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PRODUCT ENGINEERING

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1934

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Appearance, if it is an evidence of sound design and not a mask to hide technical mediocrity, paves the way to sales success

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Mechanical Design • Product Development

McGRAW-HILL PUBLISHING COMPANY, INC.

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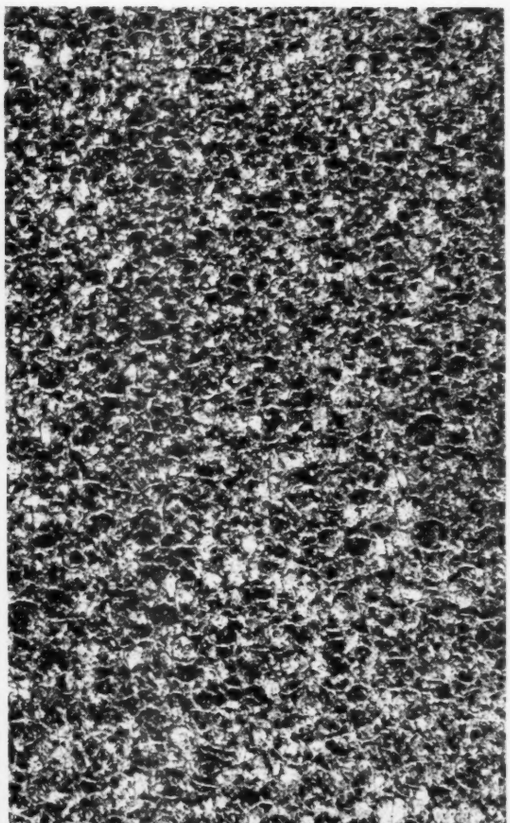

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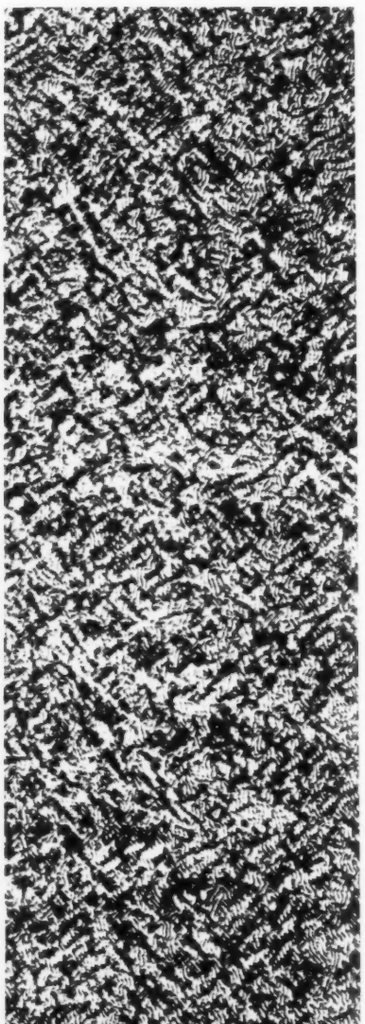

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✦ PRODUCT ENGINEERING

PRODUCT ENGINEERING

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IN THIS ISSUE

Art in Industry—What three New York expositions reveal! Trademarks! Surface Protection! Finishing! Die-Castings! Molded Plastics! An array of accomplishments and how to use the materials and processes that make the product attractive.

Motors — If securing the required data upon which to make motor recommendations is as difficult as is implied by statements from motor manufacturers, it is a severe indictment of engineers. But there is nothing to be gained by merely complaining. Therefore, in collaboration with fourteen leading motor manufacturers, we devised the Motor Inquiry Form shown on p. 145. And to help along a good cause, additional copies of this form suitably printed for use in making inquiries can be obtained free of charge upon request to the editor. How many copies do you want?

COMING ISSUES

It sounds paradoxical, but structural members can be strengthened by cutting away material to relieve concentrated stresses. In the May number R. V. Baud will tell how it is done.

Other forthcoming articles include the design requirements for magnetic contactors, jewel bearings, the determination of critical speeds and rubber for impact and abrasion.

Great progress has been made in the aviation and other transportation industries in the application of thin sections of light-weight and high-strength alloys. A forthcoming article will go into the details of the problems encountered.

KENNETH H. CONDIT, *Editor*

GEORGE F. NORDENHOLT, *Managing Editor* — R. W. CARSON, *Assistant Editor* — LEONARD CHURCH, *Cleveland* — PAUL WOOTON, *Washington*

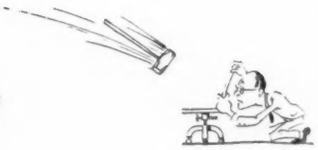
Published monthly. Price 25c. a copy. Subscription rates—United States, Mexico and Central and South American countries, $2.00 a year. Canada, including duty, $2.50 a year. All other countries $5.00 a year or 20 shillings. Entered as second-class matter January 17, 1930, at Post Office at New York, N. Y., under the Act of March 3, 1879. Printed in U. S. A. Cable address "McGrawhill, New York." Member of A.B.P. Member A.B.C.

McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42d STREET, NEW YORK, N. Y.

Branch Offices: 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, Aldwych, London, W. C. 2; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Greenville, S. C. James H. McGraw, Chairman of the Board; Malcolm Muir, President; James H. McGraw, Jr., Vice-President and Treasurer; Mason Britton, Vice-President; H. C. Parmelee, Vice-President; Harold W. McGraw, Vice-President; B. R. Putnam, Secretary

Printed by The Schweinler Press, N. Y.

Intimate Correspondence



Clippers, Ahoy!

PRODUCT ENGINEERING
NEW YORK

I most heartily endorse the statements and appeal of Mr. C. M. Dunavan on page 2 of your March issue. You can do your readers a very real service, and probably at no great trouble to yourselves, by arranging all leading articles of permanent value to start on odd number pages, and have the broken space filled out with matter of transitory value.

CHESTER B. HAMILTON, JR.,
President, Hamilton Gear Machine Co., Toronto, Ont.

And Again

PRODUCT ENGINEERING
NEW YORK

About two years ago when I was Chief Engineer of Kent Machine Co., Cuyahoga Falls, I subscribed for *Product Engineering* and do not remember when subscription expires. Will you kindly advise and change the address of magazine to this town. I have accepted a position as engineer for Holgate Bros. Co.

This last year you have been publishing some very interesting data on Clutches, Mechanisms, Ball Bearings, Pressed Metal Parts, etc. I hope you republish them in book form. You mix them up so it is hard to cut them out for loose-leaf book.

Often wonder why publishers do not use only *one* side of the sheet when printing data sheets. Then they could be kept in loose-leaf books and the other side of sheet for notes.

ERNEST W. DUSTON,
Kane, Pa.

And Once More

PRODUCT ENGINEERING
NEW YORK

The data you publish are too valuable for us subscribers to lose. Your publications are set up so they are convenient to read but not so we can have the full benefit.

The only satisfactory way that I have found to have this data available when needed is to cut it out and file it in folders under the proper heading. I have 140 folders, each one on a different subject. They are used a great deal for reference.

Please keep one subject to a sheet, crowd the heading if necessary, or fill in with short articles. Do not put parts of two main articles on opposite sides of a sheet.

WREN A. DAWSON,
Charles City, Iowa

WELL, when they come at you like that—in bunches—you have to do something about it. We thought we were trying to separate articles likely to appeal to the same type of reader but evidently the breadth of interest is greater than we thought, or else the appeal of the articles is stronger even than we had hoped. At any rate, we are making changes in the arrangement of this issue to accomplish the desired segregation.

When it comes to printing on but one side of the sheet, that is something else. Desirable as such a procedure might be, the economics of the situation prevents it now. There are too many valuable articles pressing for publication.

Proof Positive

PRODUCT ENGINEERING
NEW YORK

We know that you must have used the write-up on our new Waldron Torque Ring couplings that we sent you under date of Feb. 10th, because we recently had an inquiry from one of our old customers in which he referred to *Product Engineering*.

Will you not please send us a clipping of this article for our files? Thank you.

SMITH & SERRELL,
Newark, N. J.

AN EXCELLENT way to keep old customers informed of your new developments, and to reach new customers, is to give us the facts on your latest achievements. The announcement should be followed up by adequate advertising, of course—in *Product Engineering*, equally of course.

More Proof

PRODUCT ENGINEERING
NEW YORK

Allow us to congratulate you on the excellent article on Jewel Bearings which appeared in the March issue of *Product Engineering*. From the inquiries and comments we have received we believe it was of interest to many of your readers especially as there has been very little written on the subject. It was of such interest to us that we would like four extra copies of that issue which we wish you would forward to us and charge to our account.

JOHN WORLEY JEWEL CO.,
Waltham, Mass.

WE CAN stand lots of letters like that one.

At a Price?

PRODUCT ENGINEERING
NEW YORK

At various times you have published in your magazine *Product Engineering* Nomographic Charts which are quite helpful to engineers. As an example, I mention the two charts on pages 119 and 120 of the March, 1934, issue.

Are you in a position to furnish reprints of the various charts you have so far published and if so, how can they be obtained?

I believe that if you should print under each chart a short notice to the effect that reprints of this chart can be obtained for such and such a price, many engineers and draftsmen would be glad to take advantage of the opportunity.

I shall be glad to have your comments at your convenience.

WM. A. ROSENBERGER, *Chief Engineer, Pangborn Corporation*

EVERY once in a while a request for such reprints comes in, but they have not been frequent enough to warrant serious consideration as yet. If you feel that such reprints should be available at a nominal price won't you write and tell us so?

More Power

PRODUCT ENGINEERING
NEW YORK

The publication in *Product Engineering* of the fine articles by Mr. C. H. Grill on "The Design of Worm Gears" makes a splendid contribution to practical data on this subject. As remarked by Mr. Grill in the first paragraph of his article the design data available are signalized by a good deal of contradictory and unsatisfactory formulae, and these articles should be most welcome.

I should like to express my appreciation of the fine combination of practical designing information and applied industrial art which has appeared in *Product Engineering*, and paraphrasing W. B. Pitkin I say "More Power to You."

P. N. BLAND,
Vancouver, B. C.

TO WHICH we can only say "Many thanks, and we hope coming issues will be as valuable."

PRODUCT ENGINEERING

KENNETH H. CONDIT, *Editor*

MCGRAW-HILL PUBLISHING CO., INC. APRIL, 1934 VOLUME FIVE, NUMBER FOUR

Quackery Dies While Art Endures

EVERY new art, creed or school of thought passes through the successive stages of innovation, general acceptance, skillfully publicized fad and hectic activity. These last two stages are fostered by the horde of charlatans and quacks who spring into being as soon as general acceptance seems assured. They loudly proclaim themselves as experts, and flourish in the reflected glory of the true leaders whom they may temporarily overshadow. But finally, when true values are recognized, genuine leaders take command and the art proceeds on a sane basis.

Such was the history of "scientific management," and today we see it being repeated in industrial art. Streamlined design is acclaimed even for stationary objects, various motifs are expounded in meaningless phrases, color harmony for construction machinery is extolled and absurd mimicry abounds. Quackery is having its fling.

Quoting one of the foremost industrial designers whose accomplishments of ten years are proof of his genuine ability, "Much has been written about the importance of inspirational design and psychoanalytical design and consumers' mood sensitiveness." Deprecating this situation, he continues, "But in the end a good design is better than a poor one, and the reasonably priced better one will outsell the poorer one. . . . There is no doubt that it is only the serious minded unspectacular type of industrial designer who has a permanent place in modern industry, and a good one, too."

Unfortunately, it is almost impossible for the layman to discriminate between the genuine and the imitation. Therefore, our business executives must wait until the results of the accomplishments of industrial artists or designers have proved their worth or incompetence. And that time is now at hand. Sales records of products that are being redesigned by industrial artists will either spell "tout finis" for the industrial designer who is credited with the creation of its appearance, or it will give that designer the reputation of being an artist of ability proved by accomplishment.

Robbed of all high-sounding phrases, industrial designing is the art of giving a properly engineered product a strikingly pleasing appearance. Describing the product with high-sounding phrases will not accomplish this. The results are inevitable. Quackery in this field will be killed by its own accomplishments, whereas the true art will endure.

How Does It Look?

HOW "it" looked hasn't been so vitally important to most of us during the gloomy years of this fourth decade of the twentieth century because, until just recently, we haven't been in the market for anything beyond bare necessities. But now, with the acquisition of a job or the fattening of a pay envelope, we are beginning to take notice again. Most of us want something that looks better than the penuriously practical products with which we have had to be content.

There was a time, before 1929, when we were complacent enough to judge a purchase largely by its looks without too much worry about its other merits. But that time is no more, enforced economy has taken care of that. Now we want looks, but we want the kind of looks that go with the very best that the designing engineer has to offer in the way of performance and intrinsic value.

The two are not at all incompatible, as the work of the successful industrial artists proves. These men have not been content with mere ornamentation, realizing that to stop there usually means that the product so treated is either artistically dishonest or otherwise unsatisfactory. By getting down to the fundamentals of the design and working closely with the engineers they have usually been able to arrive at modifications that have improved appearance, or permitted a lower price and a wider market, or provided a better product at the same price, or all three.

The buyer of today does care how it looks, but he wants the looks to be indicative of the value. It is the product engineer's job to make sure that he is not disappointed.

New York Shows Feature *Product Developments*

Clean cut scale designed for Holley Carburetor Co. by Van Doren and Rideout

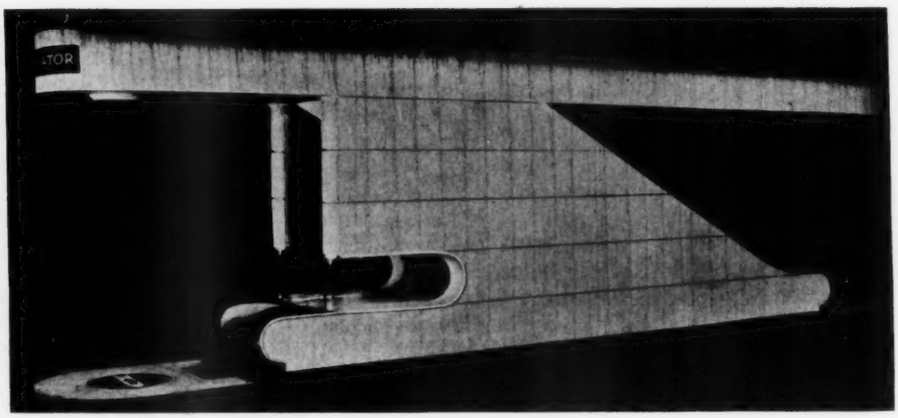
At three simultaneous exhibitions in New York this month the industrial product is the center of attention. Appearance is naturally the principal appeal to the observer

IF THERE is any virtue in the simultaneous attack, product appearance and the work of the industrial designer and the product engineer should certainly be much in the public eye this month. For not one but three exhibitions of industrial products are "on" this month in New York. Under the sponsorship of the National Alliance of Art and Industry the industrial artists are displaying their achievements in the exhibition room on the 62d floor of the RCA Building. In the same building an exhibit of synthetic dress and upholstery fabrics and molded plastic accessories is being staged by The Fashion Group. At the Museum of Modern Art, 11 West 53d Street, there is an exhibit of machine art that has been going on since the first of March.

Practically every industrial artist of note is represented in the Industrial Arts Exposition in the RCA Building. This show is distinctly a designers' affair, the executive committee being headed by Walter Teague and the exposition committee by Eugene Schoen. Acceptance of exhibits was passed on by a jury headed by Donald Deskey; and the arrangement of all exhibits was the work of Mr. Schoen.

The range of products exhibited is wide—from a handbag watch to a pre-fabricated house, and from wooden bowls to airplanes and automobiles. As this is written entries are still coming in and it is therefore impossible to give a complete list of exhibits. A few of the more outstanding are illustrated to give an indication of the type of product to be seen.

One of the best examples of what the industrial artist contributes to a product is the Todd Protectograph, of which before and after views are shown here. The designing engineers developed a model that was mechanically excellent and functioned satisfactorily. But it looked like any other piece of office machinery. Henry Dreyfuss was called in and the result is evident. The smooth, flowing lines of the pressed metal shell are attractive and the re-design of the keys makes the machine easier to manipulate. Incidentally, the sim-



Model for an escalator in a department store designed by Louis H. Pfohl for the Otis Elevator Company. Note the display cases at either side of the landing platform at the left and the inset lights above each platform. The contrast between this model and the conventional escalator is striking

plification of the shell lines made the drawing of the sections of which it is made an easier job and facilitated assembly.

Mechanically, the important development is the shift from lever to key operation. The artist achieved distinctiveness by using square keys instead of the round ones put on by the engineering department, and by substituting oblong bars for the "Ciear" and "Repeat" keys. The bars are much easier to manipulate, and tests have shown that the square keys are also easier to handle than the round ones. Notice, too, how much better the straight, simple lever looks than do the traditional curved levers of the older models.

The front and back pieces of the case are removable to permit changing of the ribbon and access to the mechanism, the trade mark on the front acting as a latch for the front piece and a small bar serving correspondingly for the back piece. The two German silver strips serve to tie the machine to its base so far as appearance goes. Lumarith is used for the keys.

When the new model was introduced to the sales department the response was enthusiastic. In the field the enthusiasm was quickly transformed into sales.

Another office machine that shows the work of the industrial artist is the Gestetner mimeograph handled in this country by A. B. Dick. Raymond Loewy was responsible for the improvement in appearance. The principal changes involve the use of bakelite housings on the machine, which have deadened the operating noises, and the housing-in of the legs and shelves below

Executive Committee

Walter Teague, Chairman — Russell Wright
Egmont Arens — Henry Dreyfuss — Eugene Schoen
Gilbert Rohde — Lucian Bernhard — Donald Deskey
Ben Nash — Alon Bement, Executive Officer.

Exhibition Committee

Eugene Schoen, Chairman
Lucian Bernhard — Gilbert Rohde — Lee Simonson
Donald Deskey — Henry Dreyfuss

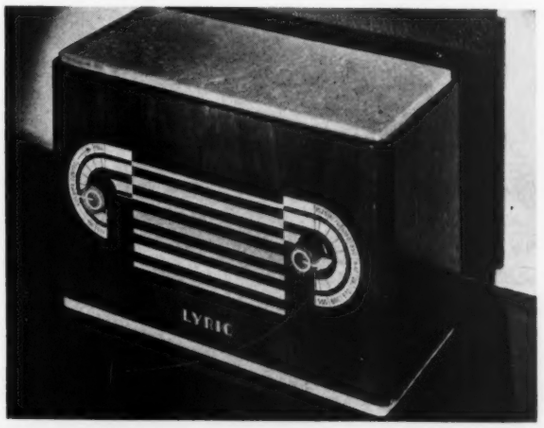
Selection Committee

Russell Wright, Chairman — Virginia Hamill
Harold Van Doren — Roy Sheldon — Isabelle Croce
Aline Davis Hays — John Vassos — Ruth Reeves
George Switzer — Gustav Jensen — Helen Dryden
Marianna Von Allesch — Walter Von Nessen

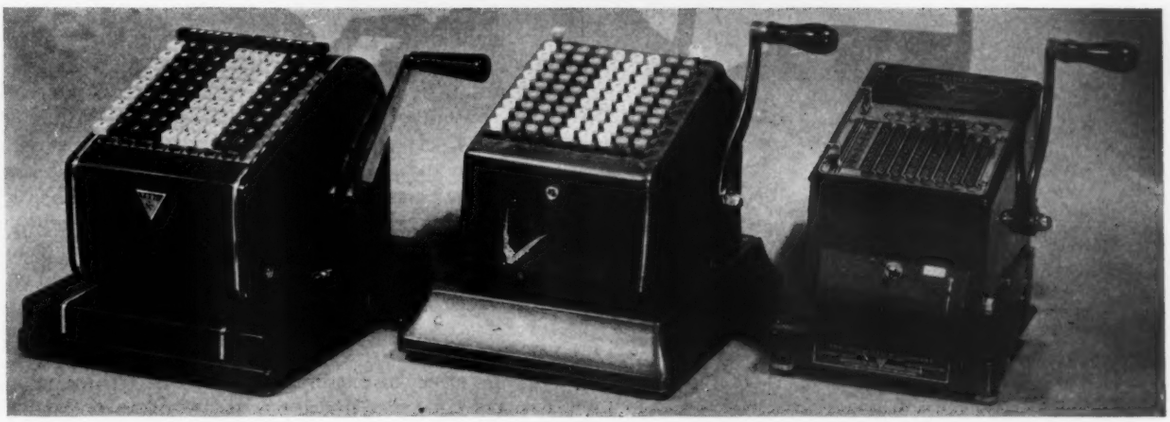
Jury

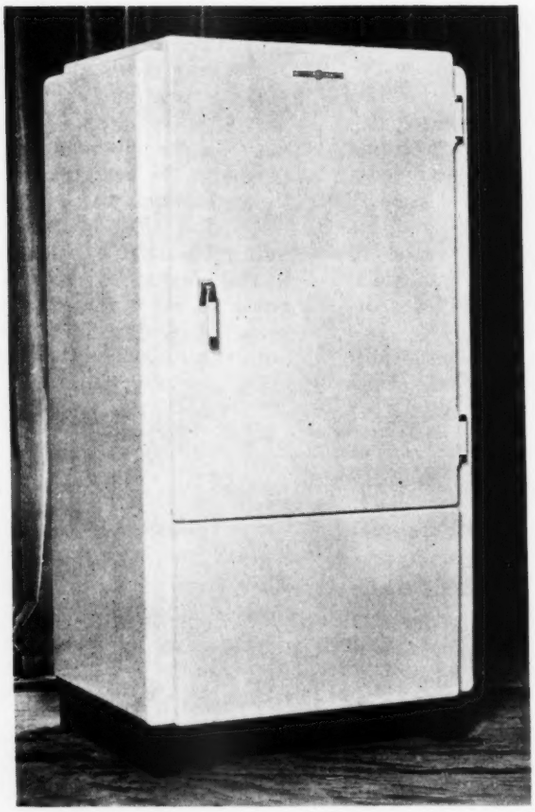
Donald Deskey, Chairman
Eugene Schoen — Walter Teague — George Sakier
Lurelle Guild — Harold Van Doren

At the right is a wooden radio cabinet designed by Russel Wright for the Rudolph Wurlitzer Company. The grille and the dials are inlaid bird's-eye maple, the case itself being of walnut. The model is called the "Ram's Horn"

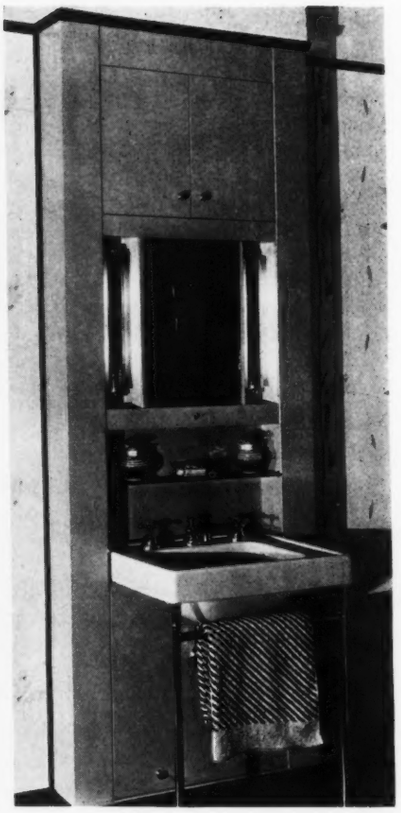


Below are three models of the Todd Protectograph check writer. The one at the right is the lever model which was superseded by the key model in the center. This one in turn was styled by Walter Dreyfuss as shown at the left





General Electric's new de luxe flat top refrigerator was styled by Walter Dreyfuss. The compressor unit is in the bottom and the legs are concealed by the black metal strip. Extreme simplicity characterizes the design

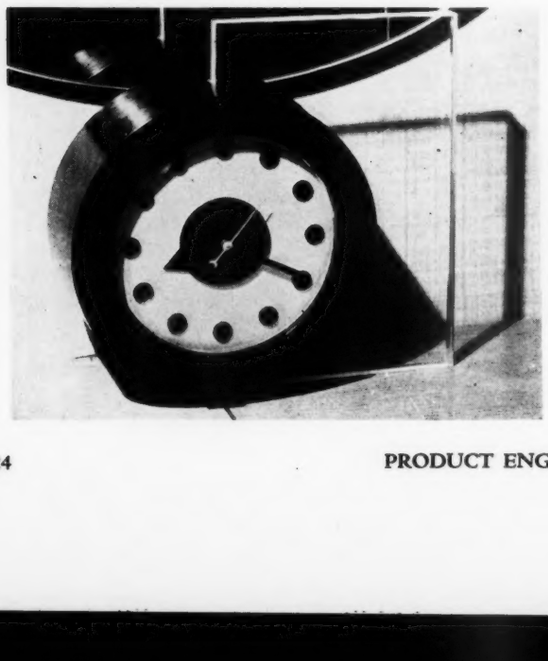


At the right is the lavatory unit built into the prefabricated house at the Industrial Arts Exposition. It is one of George Sakier's typical designs. A few bolts hold the unit in place. Built-in vertical tubular lights flank the mirror

the duplicating unit to improve the looks. The use of bakelite for the housing has resulted in a surface less subject to scratches and the usual wear and tear of office work.

A model of a department store escalator designed for the Otis Elevator Company by Louis H. Pfohl shows again how attractive simple lines can be, and what an improvement is possible in this usually unattractive contrivance. Note the display cases at either side of the landing platform and the inset lighting fixtures at either end of the upper structure.

This clock is an ingenious modernistic combination of wood and glass. What looks like a thin metal supporting bracket is the ground edge of the glass plate



The Coca-Cola dispenser designed by John Vassos in cooperation with the engineers of the Coca-Cola Company and Frigidaire is a combination of bakelite and aluminum housing a Frigidaire unit and a 3-gal. container. It is intended both as a display and as a dispensing device. The aluminum lower section is intended to represent the cooling coils of a refrigerating machine to give the customer the impression of coolness. The upper section is high enough to clear the standard fountain glasses.

There is a reason for the ribbed structure on the top. It is designed to prevent the merchant from standing bottles (of other drinks) on it and thus detracting from its appeal as a display.

Russell Wright's "Ram's-horn" radio for the Rudolph Wurlitzer Company is an example of what can be done with different woods, walnut and bird's-eye maple. Its severe simplicity should appeal to the engineering eye, as should that of the "Kwik-Wate" scale designed for the Holley Carburetor Company by Van Doren and Rideout. Even more modern in style is an electric clock by Gilbert Rohde for the Herman Miller Clock Company. It combines wood and clear glass with an aluminum dial. What isn't evident in the illustration is that the support for the cylindrical clock body is a sheet of plate glass with ground edges. The edges give the effect of a thin white metal band as a support.

Turning to the field of domestic machinery and equipment there is the new de luxe flat top General Electric refrigerator designed by Dreyfuss. This model is illustrated because it is an excellent example of the pleasing effect of extreme simplicity of treatment. The legs are concealed by a pressed steel strip finished in

black. The compressor unit is underneath the cabinet and the temperature control unit is located on the front of the stainless steel cooler. Exterior finish is glyptal baked enamel, interior finish consists of three coats of stain-resisting porcelain fused to the steel inner liner. Corners are rounded for easy cleaning. Improvements in the mechanism include an automatic belt tightener, rubber motor mountings, an improved shaft seal, and rubber casings for the wiring and tubing.

Of real importance to every engineer interested in domestic equipment, lighting fixtures and plumbing units is the three-room prefabricated house designed by Holden, McLaughlin & Associates and built by American Houses, Inc. The exhibit at Rockefeller Center is sponsored by Lord & Taylor, and *House Beautiful-Home and Field*. The importance lies in the effect this design will have on the various units included in it. All of them, of course, are factory-built and assembled on the plot. The design of the equipment to be built into a prefabricated kitchen or bathroom is something new in the engineering field. One such unit, a wash basin with the necessary accessories in the way of lights, mirror, medicine cabinet and plumbing fixtures, is illustrated. It is the design of George Sakier, whose work in this field is well known. The whole unit can be installed by tightening a few bolts and making the usual pipe connections.

Since this number goes to press before the completion of the arranging of the exhibits it is impossible to show any illustrations of Mr. Schoen's work in unifying the exposition.

Outside of the main exhibition there are several units too big to fit into the limited space available. One of these is the streamlined rear-engine tank truck developed by the Texas Company. This vehicle is located on the plaza outside the RCA Building. Automobiles to be found here or possibly inside (just where has not been decided as this is written) include Pierce-Arrow, Chrysler and Hupmobile current models.

Exact figures will not be available until the last moment but at present there are more than 300 industrial designers listed among the exhibitors. In addition, space has been taken by industrial companies and department stores. Among them are the Westinghouse Electric & Manufacturing Company, General Plastics, Formica Insulation Company, E. I. duPont de Nemours & Company, and two of its subsidiaries, New Jersey Zinc Company, Kennecott Copper Corporation, American Catalin Company, Toledo Synthetic Products Company, and Eastman Kodak Company.

Side frames and front of bakelite and the wooden cabinet were Raymond Loewy's principal contribution to the appearance of the Gestetner mimeograph

Exhibition of Machine Art

Quite a different sort of exhibition is in progress at the Museum of Modern Art. Here the products of the machine and some of the machines themselves are exhibited to illustrate the purely artistic merits of such objects. Some of the objects displayed are the work of exhibitors at the other show but many of them represent designs that are without benefit of artistic aid, as will be evident from the illustration showing a corner of the first floor arrangement. Most of the objects shown are from subsidiaries of the United States Steel Corporation. Incidentally the section of a coil spring shown in a separate illustration and just visible on the shelf to the left of the nine tubes on the rear wall was at one time leading in the votes of

This Coco-Cola dispenser contains three gallons of fluid and a Frigidaire unit to keep it at constant temperature. The works are the contribution of the Coca-Cola and Frigidaire engineers, the shell that of John Vassos. Aluminum and bakelite are the materials used for the case

visitors for the most beautiful object in the exhibition.

For our illustrations of exhibits we have chosen just a few of the metal products included. They offer clear evidence of the enduring attractiveness of the simple geometrical figures and the artistic possibilities inherent in their combination in various ways.

In a way we are returning to an appreciation of beauty comparable to that of the Greeks. Plato said, nearly 2,500 years ago: "By beauty of shapes I do not mean, as most people would suppose, the beauty of living figures or of pictures, but, to make my point clear, I mean straight lines and circles, and shapes, plane or solid, made from them by lathe, ruler and square. These are not, like other things, beautiful relatively, but always and absolutely."

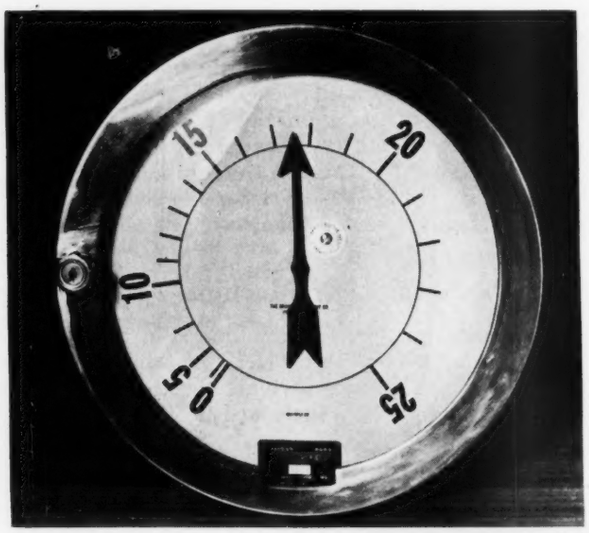
Commenting on this quotation, Mr. Alfred H. Barr, Jr., director of the Museum of Modern Art, points out that, "In Plato's day the tools were simple handworker's implements. But today, as a result of the perfection of modern materials and the precision of modern instruments, the machine-made object approaches far more closely those pure shapes the contemplation of which Plato calls the first of 'pure pleasures.'

"Machines are, visually speaking, a practical application of geometry. The lever is geometrically a straight line resting on a point. The wheel and axle is composed of concentric circles and radiating straight lines. Screws, coil springs and propellers are various —and variously beautiful—applications of the helix and the helicoid."

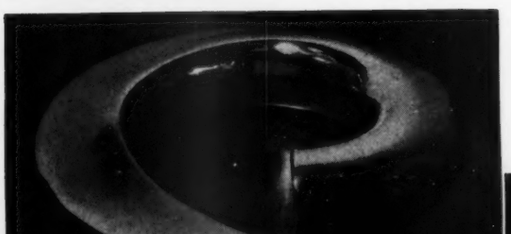
This is language that an engineer can understand but it is a rarity in the field of art. It should encourage the designing engineer to maintain his faith in the value of honesty in design as indicated by the avoidance of material imitations, and his natural preference for directness and simplicity in the choice of forms.

Such exhibitions as these should go far to educate the public taste to acceptance of what is fundamentally correct in design and to rejection of the spurious.

In his foreword to the excellent catalog prepared for this exhibit, the director, Philip Johnson, has this to

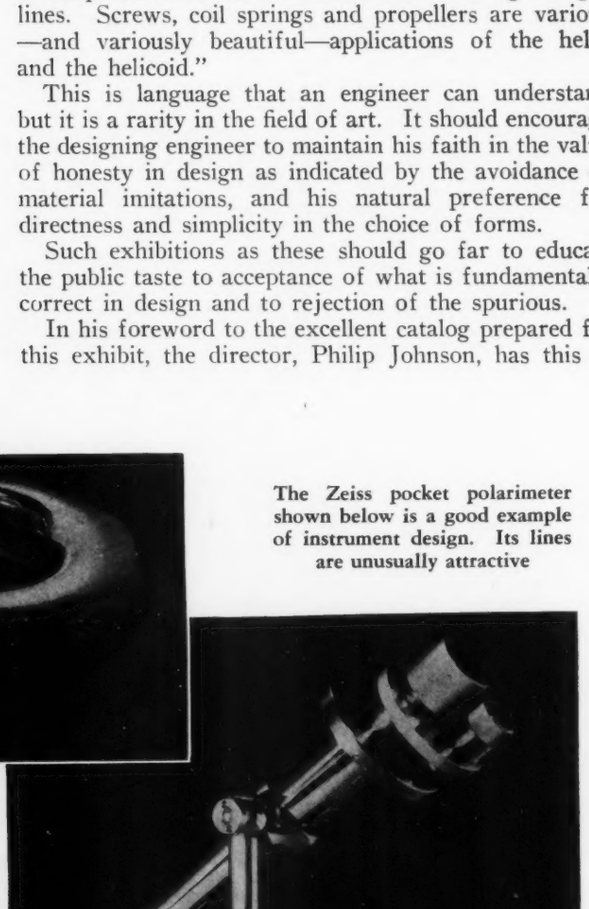


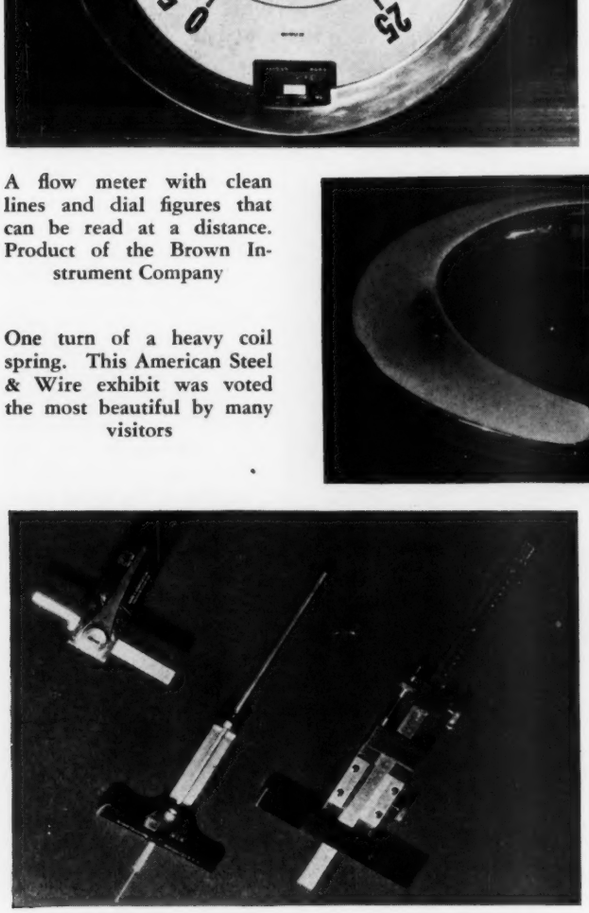
A flow meter with clean lines and dial figures that can be read at a distance. Product of the Brown Instrument Company



The Zeiss pocket polarimeter shown below is a good example of instrument design. Its lines are unusually attractive

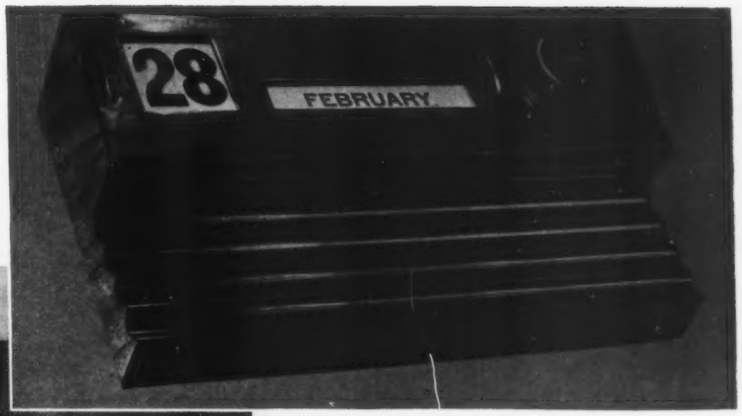
One turn of a heavy coil spring. This American Steel & Wire exhibit was voted the most beautiful by many visitors



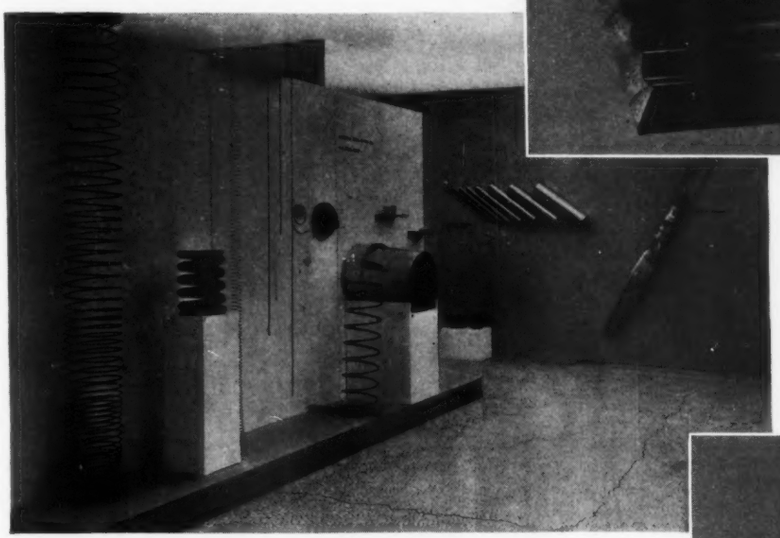


Three of the well-known measuring devices for toolmakers made by Brown & Sharpe are shown above. Their attractiveness lies principally in their appropriateness for the job

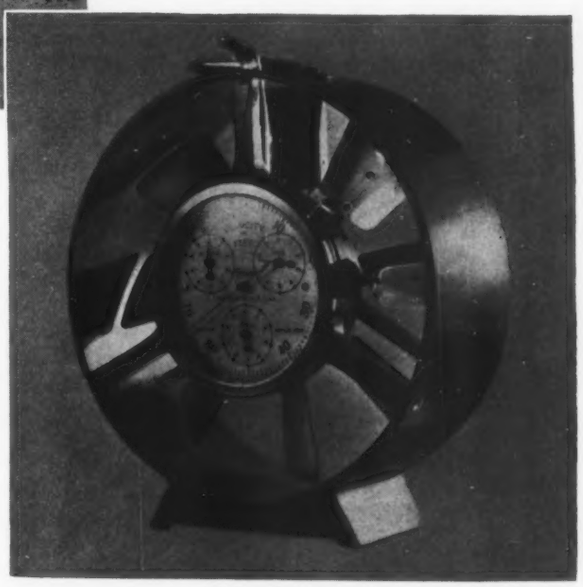
A simple and practical combination inkstand and calendar designed by a firm of architects, Howe & Lescaze



A view near the entrance to the Machine Art Exhibition at the Museum of Modern Art



The anemometer shown in the illustration below is a product of the Taylor Instrument Companies. Rather more complicated in form than most of the other exhibits it is still an attractive piece of design



say about machine products and the examples chosen for display: "The situation in America has been somewhat special. In the '20's we received a wave of foreign influence from France. Though France herself was influenced by central Europe, the Paris Exposition of Decorative Arts in 1925, with its neo-classic trappings and bizarre ornaments, made a strong impression on our designers. The problem in America has not been the conflict against a strong handicraft tradition but rather against a 'modernistic' French machine-age aesthetic.

"Besides the French Decorative movement in the '20's there developed in America a desire for 'styling' objects for advertising. Styling a commercial object gives it more 'eye-appeal' and therefore helps sales. Principles such as 'streamlining' often receive homage out of all proportion to their applicability.

"The exhibition contains machines, machine parts, scientific instruments and objects useful in ordinary life. There are no purely ornamental objects; the useful objects were chosen for their aesthetic beauty. Some will claim that usefulness is more important than beauty, or that usefulness makes an object beautiful. This exhibition has been assembled from the point of view that though usefulness is an essential, appearance has at least as great a value."

The Fashion Group Exhibit

In the third of the three simultaneous New York exhibitions the average designing engineer will have less interest. Machinery is hardly in the picture here, the emphasis being rather on materials, and specifically on the synthetics—the plastics, rayons, acetates and cuprammoniums. Some of the synthetic fabrics are being shown for their style value, others for their ability to resist wear, moisture and chemicals.

Supplementing the fabrics are accessories, furniture, lamps, etc., made of the various plastics familiar to most readers of *Product Engineering*. Some of them have new applications, however, and many of these are being shown to consumers for the first time. This part of the exhibit should be productive of ideas for the designing engineer who has to work with these materials and for the consumer market.

In conclusion it should be remarked that these three shows are entirely independent. The fact that they are being put on at the same time should produce a real impression on the public.

Towboats used by this company supplied the motif for a trademark, the product not being possible pictorially

TRADEMARKS — their relation to the product

OTTO KUHLER
Design Engineer

TRADEMARKS are as old as trade. Knights, barons and kings had them, and nations adopted them as a mark of identification. In the early days a combination of different colors in a flag was usually recognized as sufficient. But as guns, airplanes and battleships increased the range of military operations, it became evident that a combination of colors alone would not be distinguishable and distinctive designs were developed. Thus the Allied forces in the World War used the red, white and blue circle on the wings of their planes the opposing forces the Maltese cross.

The symbols used as trademarks today have their origin in the old shingles of the craftsman guilds, and the form of the shingle that hung in front of the guild house was derived, in turn, from that of the shields of knights. The outlines can still be discovered in many trademarks.

There is one interesting thing about these old signs. With the uncanny sense for proportion and beauty of line that these artisans of past centuries possessed by pure intuition, they invariably created good signs. As the old guilds split up, the different individual manufacturers demanded new trademarks of their own, and the search for individuality began. Thousands of trademarks were designed and it is only logical to assume that the busy manufacturer, himself no longer a craftsman, could not see the intrinsic value of a trademark and left it to the artisan to design one for him.

But the artisan too had been industrialized to the extent that he no longer thought in the same terms as the old craftsman who not only knew design instinctively, but product and markets as well. It was only natural, therefore, that he should search among already existing designs and apply them. Before long the outward form of a trademark became standardized into a knight's shield, a keystone, a star or some similarly distinctive graphic form. This standardization led to enormous abuse in the flooding of markets with similar trademarks, and to the necessity of legislation to control them. Unfortunately, this legislation naturally induced mediocrity.

As an example of this mediocrity and lack of originality, let us take the trademark of the State of Pennsylvania, which is a keystone. Now there are thousands of Keystone Banks, Laundries, Bakeries, Restaurants, etc. They all use some form of a keystone as a trademark, but as they cater mostly to local trade this trademark has little value, and no opportunity for the distinction that it would have outside the border of the State. It is useless to advertise the type of trademark.

Rolling mills built by the Aetna-Standard Engineering Company suggested a trademark made up of the company initials

In the development of trademarks certain symbols have been accepted as representative of the performance or properties of a product that a company wanted to advertise. Thus the wheel is used for transportation, the sword or armored knight for protection, the anchor or flag for shipping, the old Egyptian oil lamp for enlightenment and instruction. Although these symbols and many others are established and are therefore useful for quick identification, their application to a trademark should not be left to unskilled hands. Generally speaking, only a master designer can use such established symbols to achieve a new and distinctive design. Obviously, if the trademark is not distinctive it has no commercial identification value.

The restyling and redesigning of the products of today has put new limitations on trademark design. Unfortunately, we still have many good trademarks that were originally satisfactory, but are not now appropriate for use with the current product. As a consequence they are handicaps, rather than ornaments, to the appearance of the product. A good designer should be able to simplify and modernize these designs without killing their individuality, and thereby save the manufacturer the money already spent in establishing the old design. If the trademark is original, simple and practical in its applications, little expense

is involved in impressing it upon the prospective buyer's mind. But if it is intricate, hard to reproduce and hard to apply, the manufacturer will have to spend a lot to establish it, and may even then fall short of his object. The initial cost of the trademark design should not be considered as of prime importance, because if it is designed right, it is likely to persist for years or even centuries. A typical example of such a trademark is the trademark of "Twin Brand Cutlery" which celebrated its two-hundredth anniversary a few years ago. It is worthy of remark that this trademark was designed by the manufacturer himself who at that time was not only a manufacturer, but a skilled craftsman proud of his trade.

Of recent years mergers and reorganizations have forced new trademarks into being simply because any attempt to combine the two or three marks and names involved in the merged products usually ended in a hopeless mess. Here again it pays to enlist the services of a qualified designer.

In what follows I have attempted to set down some rules within the limitations of which a successful trademark design can be created. The artist, as well as the manufacturer, should make sure that the answers to all of these questions, so far as the product in question is concerned, are determined correctly.

Questions

1. What is the product to be trademarked?

The answer to this question should indicate whether the product will have outstanding appeal in itself by being new in the market, or having qualities distinctively different from those of similar products.

2. Who will buy it? Men, women, children?

The answer to this question tells whether the appeal to be embodied in the trademark design shall be to the masculine, feminine or juvenile mind.

3. Where and how is it to be sold? Locally, nationally, internationally?

The answer to this question should decide whether the design shall be of local, national or international interest. For example, there are many markets in the world that consume a vast quantity of goods where the buyers are illiterate and uninformed. It is useless to advertise a product in the Tropics that shows a walrus as a trademark, because the native is not familiar with it. A hand, an eye, a hatchet or some object commonly known the world over will be a better symbol to use. Political influence must be considered and if the design carries a name, the foreign languages concerned will have to be taken into consideration.

4. Of what material is the product made?

Upon the material used in the product will depend whether the design of the trademark shall suggest strength, lightness, daintiness, etc.

5. How will the product be distributed? Wholesale, retail or both?

The answer to this question will go far to sav whether the trademark design shall be simply pictorial or shall contain a suggestive name or phase. Another thing to consider is whether the distributor will add his name to it.

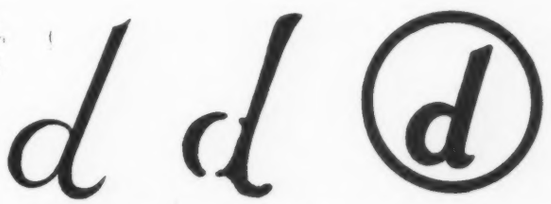
6. How is the product packed? Box, cardboard, bottle, can, etc.?

The answer to this question should decide whether it is necessary to adopt a trademark design that will look as well on the package as it does on the product itself.

So much for the commercial factors concerned. Another very important factor is that of style appeal. For a short lived product where the style appeal is paramount, the trademark design should follow the general character of the product. If, on the other hand, the design is to be applied to a whole line of products, as in the case of the company manufacturing heavy machinery and at the same time household products, it would not be wise to limit the trademark design to a particular style such as Gothic, Colonial, Byzantine, or any other. Some more or less neutral style that can be applied readily to any one of these products without clashing with the character of the product will have to be chosen.

Technically there are limited possibilities if the trademark is to be used extensively and inexpensively. The application of a second color is not always practical for the design must still look well even if one or more colors must be dropped for technical reasons. The perfect design must be suitable for any kind of reproduction. It must be recognizable and distinct if greatly reduced or enormously enlarged. It must look as well on the house flag as it does on the letterhead. It must be cast, stamped, stenciled, embossed, hewn in stone or carved in wood, molded, woven, projected, etc. It must be distinct if used in a second dimension, as for an illustrated sign. These limitations demand a design in which the application of pressure as in printing or stamping will not harm the die, and where the design is to be cast all lines must easily fill with the fluid metal.

While it is usually true that the design of the product influences the design of the trademark there exist



The first letter will look like the second one after repeated use on a cast product. Encircling and strengthening it as shown at the right makes it far more durable

instances where a well-established trademark may affect the design of the product.

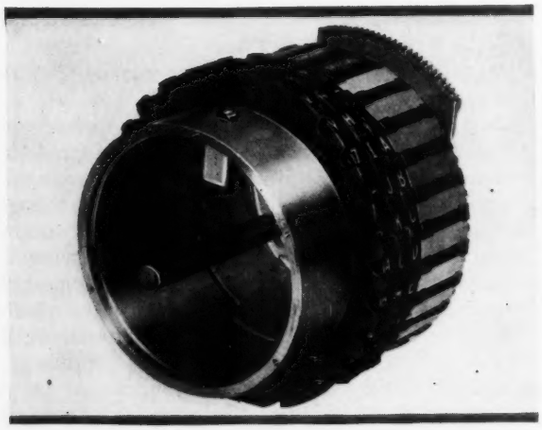
Product design is advancing so rapidly towards better form that the trademark must be considered as a distinctive part of the product and not as something that is painted, pasted or glued on as an afterthought. In applying the trademark to the package or container the effect should be that of an ornament serving for identification. Generalization as to the placing of the trademark on a product is impossible for the placing depends entirely on the character and material of the product and what the trademark is to do for it. If it is to be used solely as an identification, it may be put almost anywhere, but if it is to do an advertising job it should be displayed conspicuously. In my estimation the decision on this point may well be left to the sales manager, because so many merchandising factors will enter into the problem.

Problems in Designing for Die-Castings

M. G. DEMOUGEOT
Assistant Factory Manager
International Banding Machine Corporation

In the design of the Initialator in which 38 of the 57 major parts are die-castings, numerous problems relating to draft, shrinkage, warpage, flash, wear and ejector pins were encountered. The author explains how these difficulties were overcome

IN THE development of a portable hand-operated printing and initialing machine, it was necessary to give equal consideration to three factors—cost, appearance and simplicity of operation. The machine was for use in department stores and specialty shops for the purpose of stamping indelibly on hosiery, gloves, underwear, linen and similar goods. The printing included the name of the store selling the article, the initials of the purchaser, and the color, size or symbol of the article sold. Because the machine was for store use, appearance was an important factor. Also, its operation had to be simple and its cost had to be low.

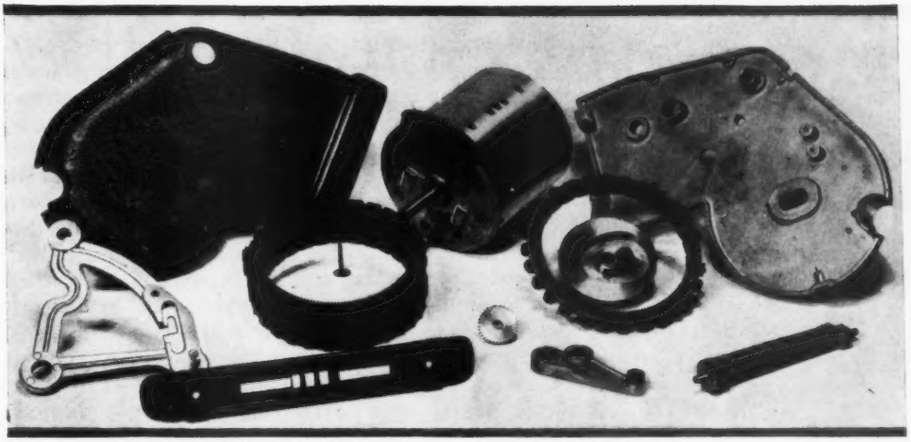


Printing wheels die-cast with internal gear teeth and type faces on the periphery rotate on a cylinder of the same alloy. Tests show there is no appreciable wear even when the wheels are not lubricated

Recognizing the improvement made in recent years in die-casting alloys, and the possibility of obtaining fine detail in die-casting, the engineers of die-casting companies were consulted. As a result, 38 of the 57 major parts of the machine are made of zinc alloy die-castings. In addition, 23 of the 38 die-castings fit into one another, or rotate surface to surface with each other, with but little machining at the contacting surfaces.

One of the sources of economy in the use of die-castings is the elimination of machining operations. But in fitting unmachined die-castings together it will be found necessary to consider draft, shrinkage, and warpage. Contrary to the average opinion, die-castings from the same mold are not all exactly alike, because shrinkage and warpage is not uniform. Also, general tolerances in one run of castings may vary from a succeeding run. In designing die-cast parts that are to be fitted together, corresponding drafts must be provided as well as ample clearance to compensate for these variations. It is better to allow ample material for machining rather than to depend on dimensions established by the die. Since die-castings machine freely, the machining operations will add but little to the cost and the effect of shrinkage, warpage and variations will be eliminated.

On the other hand, there are places where draft and surface contours can be used to hold other parts in place, but this also is limited by shrinkage and warpage. In the development of this initialing machine the thin sheet-metal covers which closed the space between the right and left sides were first



Each of these die-cast parts presented special problems. Because of variable shrinkage the end cover plates could not be held in place by drafts; warpage made it necessary to machine the printing cylinder; end plates required bronze bushings for two bearings, while the die-cast printing rings rotated on the die-cast cylinder without lubricant

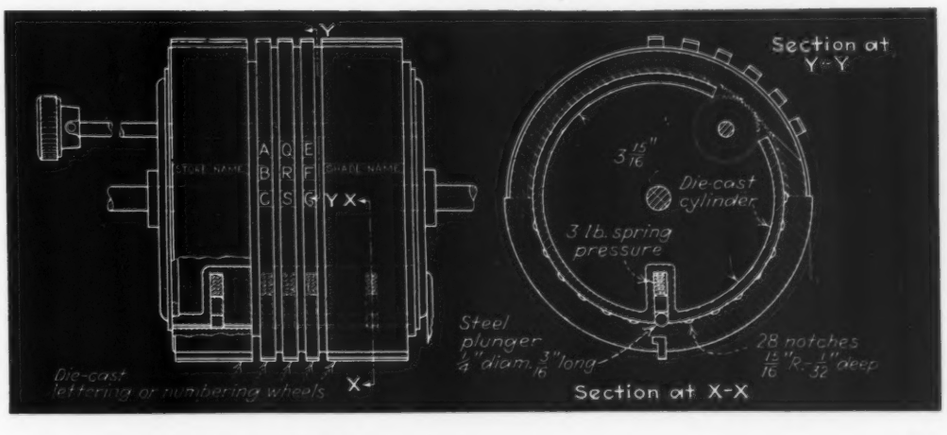
designed to be held through tight fits with the corresponding draft and the irregular contour of the two side frames. However, after the dies were made it was found that the sheet-metal covers were loose, and it was necessary to alter the dies to provide stops to keep the sheet-metal parts in place. The cost of such changes after the dies are completed is usually high, while a projection or an indentation can be added to the casting with little expense. For this reason, it is better to provide positive stops that will be certain to perform the required function, rather than to depend on the variable amount of grip that can be afforded by drafts or small irregularities in the contour.

Construction can be simplified if machined surfaces of die-castings can be used to serve as a bearing surface. In most cases, zinc alloy die-castings have a fine grain structure which wears well under ordinary conditions. Because it is inherently "oily," a zinc alloy bearing surface, even when not lubricated, will give satisfactory service if unit pressures are low and the speed is relatively slow. In the design of the initialing machine there are five wheels working side by side and rotating at 60 r.p.m. on a cylinder of the same alloy. The faces of the wheels are not machined, but the inside diameter of the wheel is bored and the outside diameter of the cylinder is turned. A bearing clearance of 0.004 in. is provided for the bore of the wheels and the side clearance as well. Machining operations on the bore of the wheel and the outside of the cylinder remove most of the chilled hard outer surface of both of the parts.

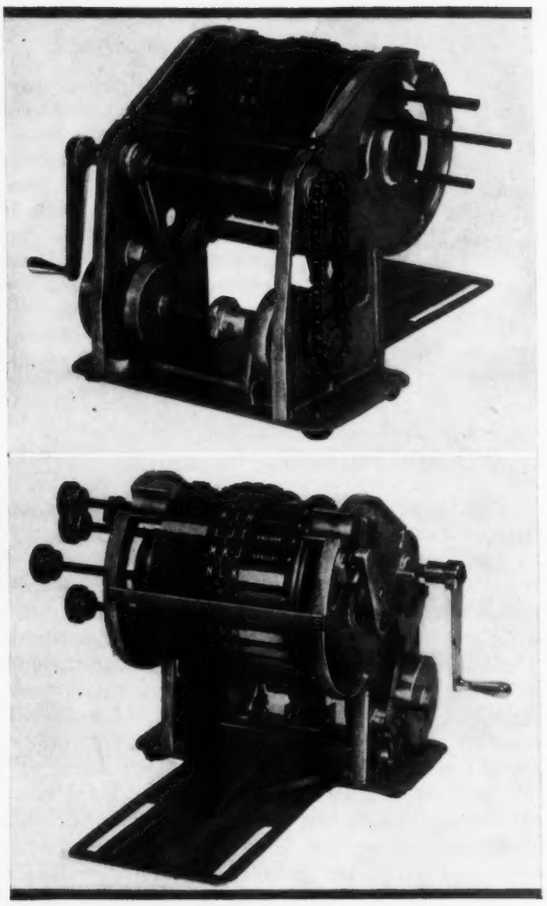
In this rotor assembly, shown in the accompanying drawing, there are two principal points of wear. Scoring, seizing or excessive friction may occur at the bearing surfaces, and the edges of the positioning notches in the bore of the wheel may wear under the 3-lb. spring pressure of the plunger in the course of 300,000 operations estimated for a year of service. To test the life of this design, an assembled test unit was mounted on a lathe and the cylinder rotated at 60 r.p.m. without lubricant. After each 50,000 revolutions the unit was taken apart and examined. After 100,000 revolutions, rounding of the corners of the notches was barely perceptible, and at the end of the test, after 300,000 revolutions, the corners were still in good condition. There was no appreciable wear in the bore of the wheels, the outside diameter of the cylinder, or the side faces of the wheels.

Although this test showed that the die-castings have a structure which will withstand considerable wear under these conditions, this conclusion holds only for the particular design tested. Each application will have its own characteristics and peculiarities, since unit bearing pressures, bearing surface velocities and lubrication conditions vary with each design.

In the use of die-cast gears, pinions, sprockets and gear segments, there will be a saving in cost if a quantity of one kind of gear or pinion is required. When only a few of one design are needed, but a



Internal gears die-cast into each of the lettering wheels mesh with gears on the hand wheel shafts so that the desired combination of letters can be selected. Spring-backed rollers snap into cylindrical slots to hold the wheels in position on the cylinder



Gears and gear sectors, chain sprockets, internal cams, levers, side plates and printing wheels are all die-cast

number of different gears are required, it is possible to group all the gears in one molding die with a saving in cost. Further reductions in cost are possible if the gears or segments can be cast integral with the parts with which they are to rotate. As well as decreasing the cost, this simplifies the design and adds strength and rigidity to the construction. For the same reasons, it is an advantage to cast locking lugs, timing marks, ratchets and similar parts integral with the pinions or gears.

Some die-castings, because of their shape, size and cross-section, become distorted while being machined. This distortion is caused by internal shrinkage stresses in the castings which cause the part to change its shape when the stressed material is removed. No set rule covers such a condition as each piece has its own peculiarities. If a high degree of uniformity is required, die-castings may require a straightening or machining operation. Although standard tolerances are established by die-casting companies, these tolerances do not cover all the conditions that arise, so that it is advisable to consult engineers of the die-casting companies when establishing tolerances.

Through the elimination of machining, die-casting also saves cost in making cams. The shape of the die-cast cam paths can be made accurately, and the die-cast cam will withstand considerable wear. For internal cams, the drafts in the cam roller groove and the accuracy of the contour are two important design points. If the load is continuously on the inner race or the outer race of the cam groove, and if the groove is not too deep, the race on which the load is carried can be cast without a taper. All of the required drafts are then placed on the opposite wall of the groove. If the load during the cycle of operation is applied to first one race and then the other, a minimum draft is applied to both races and a tapered cam roller used. If the contour of the cam as cast is not sufficiently accurate, it is usually possible to make it so by burnishing with a punch of the exact shape and size required.

Assembly operations also can be simplified by using die-cast cams. For example, a hole can be cast through the body of the cam directly opposite the top center or wherever desired, and this hole can be used to position the cams when they are placed in an assembly fixture.

Under most conditions, die-cast lettering and numbering wheels are entirely satisfactory, but there are several factors that must be considered. The parts should be made as plain as possible and should be of uniform cross-section. The characters should be as large, broad-faced and shallow as possible. If greater accuracy is required, the die-cast letters or figures can be ground off to give a uniformly smooth face and sharp outline. Grinding burrs can then be eliminated by the use of a bristle brush.

Ejector pins required in most molds leave an impression on the die-cast surface, twenty or more pins being used at times on die-castings weighing two or three pounds. Wherever an ejector pin is added to the part drawing by the die-casting engineer, the designer should see that the boss does not cause interference with any other part of the device. If a small pad or other flat surface is used without a machining operation, the drawing should specify no ejectors in this area. If the surface where the ejectors are placed is to fit against another surface, the ejector pin marks should be specified to be fully depressed below the working surface, so that when the parts are cast the flash of metal around the edge of the mark can be readily removed.

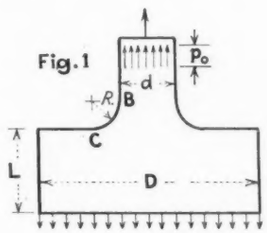
In addition to the fact that die-castings are a distinct asset to the machine or device that must be made for a price, there are instances where the use of die-castings is based on other considerations. The appearance and surface finish of the product can often be improved through the use of die-castings. Mechanical design can be simplified by casting a number of separate parts in one piece. And there is the possibility of using inserts of brass, steel or other materials.

Die-castings are not a cure-all, and good judgment must be used in determining where and how to use them. Because of the highly specialized character of die-casting manufacture, the designer will find it to his advantage to consult the engineers of the die-casting companies concerning even minor details, particularly on parts that are complicated. Many factors relating to the manufacture of die-castings are known only to the specialists in that field, so that these specialists can often suggest ways and means by which an apparently impossible design can be accomplished or worth-while savings effected.

Fillet Profiles for Constant Stress

Practical designs of fillets that will give the greatest economy of material and will avoid concentrated stresses, as determined by a semi-theoretical method and checked by photoelastic tests

DR. R. V. BAUD
Formerly Research Laboratories
Westinghouse Electric & Manufacturing Company



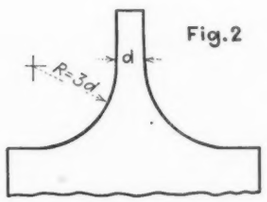


Fig. 1—Stress concentration depends on the ratio of *R*, *D* and *L* to the dimension *d*

Fig. 2—If radius *R* is equal to or greater than *3d*, there will be no stress concentration in the fillet

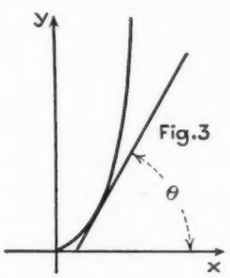


Fig. 3 — Contour of the free water jet plotted from the equations given in the text

FOR many years sharp corners and small radial fillets have been recognized as inherently weak spots in structures, but only recently has it been possible to determine the amount of increase in stress caused by abrupt changes in such sections as shown in Fig. 1. Today, photo-elastic methods make it possible to determine the maximum stress in the fillets and from this data determine a stress concentration factor. Using this stress concentration factor k, the maximum stress in the fillet p_{max} is given in terms of the average stress p_o by the formula:

$$p_{max} = kp_o$$

Extensive studies made during the past ten or fifteen years show that the factor k depends largely upon the shape of the section, and may be as large as three or even more for a fillet radius of less than $\frac{1}{16}$ the width of the small section d in Fig. 1. To have a stress concentration factor of unity, the radius must be about three times the dimension d giving a design shown in Fig. 2. But this is neither practical nor economical, because the stress decreases in intensity along the contour from B to C. The most economical contour from the material and stress point of view is one in which the stress is constant for the entire contour, and is equal to the average stress across the section.

A mathematical solution for such a problem requires the integration of simultaneous differential equations of the second order, which is possible only in a few favorable cases. A "semi-theoretical" solution can be obtained from a hydrodynamical analogy if the analogy can be proven to apply to the stress problem. The contour, known in hydrodynamics as the "free jet of water" contour has a mathematical solution, and because of the constant velocity of water at the boundary may be the contour of constant stress.

The curve of this contour is shown in Fig. 3, and is given by the following equations:

$$X = 2C \sin^2 \frac{\theta}{2}$$

$$Y = C\left[\log \tan\left(\frac{\theta}{2} + \frac{\pi}{4}\right) - \sin\theta\right]$$

In these equations, C is a constant equal to $2b/\pi$ where $2b$ is the distance between the assymptotes, and

TABLE I
Values of $y = f(x)$ for the Free Jet Contour

x	y	x	y
0.00	0.0000	0.60	0.6494
0.02	0.0008	0.70	0.9203
0.04	0.0060	0.80	1.3127
0.06	0.0138	0.90	1.9915
0.08	0.0224	0.92	2.2000
0.10	0.0313	0.94	2.5000
0.20	0.0932	0.96	2.9000
0.30	0.1815	0.98	3.6000
0.40	0.2985	0.995	5.0000
0.50	0.4509	1.00	.....

TABLE II
Values of x, $y = f(\theta)$ for the Free Jet Contour

θ	x	y	θ	x	y
0	0.0088	0.0000	75	0.7400	1.0620
5	0.0038	0.0001	80	0.8280	1.4450
10	0.0152	0.0002	82.5	0.8680	1.7305
15	0.0338	0.0040	85	0.8940	2.1290
20	0.0606	0.0140	86	0.9300	2.3511
25	0.0934	0.0280	87	0.9460	2.6385
30	0.1340	0.0480	88	0.9660	3.0437
40	0.2340	0.1180	89	0.9820	3.7366
50	0.3580	0.2440	89.2	0.9880	4.1410
60	0.5000	0.4509	89.4	0.9940	4.8330
70	0.6600	0.7960	90	1.0000	.....

Note: For plotting the curve, the values of x and y given here must be multiplied by C, as explained in the text

θ is the angle between the tangent to the curve and the x-axis. Values of x in terms of y are given in Table I, while Table II gives the values of x and y in terms of θ. The values of Table I are determined with greater accuracy than those in Table II.

Theoretically, θ becomes 90 deg., for an infinitely large value of y, a consideration which is impractical in design work. However, for $y = 5C$, the theoretical angle is within half a degree of a right angle, and $x = 0.995\,C$. Using a constant of unity instead of 0.995 for C, and adjusting the curve to join smoothly with the theoretical curve and points immediately below, there will be but little deviation between the practical and the theoretical curves.

In Fig. 4 is illustrated a method of plotting the curve when, for example, $d = 2b = 1$ in. As shown,

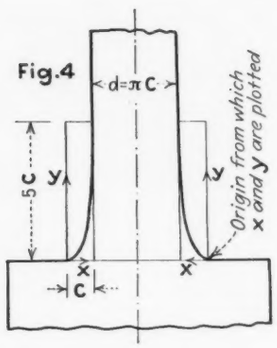


Fig. 4 — Here is illustrated the method of plotting the profile of a fillet of constant stress. The values of x and y are taken from the table and plotted as indicated

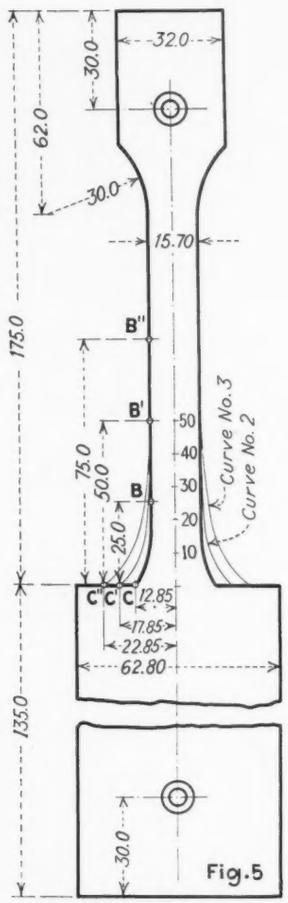


Fig. 5—Detailed dimensions of the specimen tested for experimental proof as to the correctness of the theoretical fillet. Dimensions are given in millimeters

the method is to draw a rectangle with one side equal to $C = 2b/\pi$ or 0.318 in., the other side being equal to $5C$ or 1.59 in. The values of x and y from Table I are multiplied by 0.318 in., and adjusted, as mentioned previously, to form a smooth curve. For a cross-section with values of d other than 1 in. the values as obtained above for $d = 1$ in. are multiplied by the given value of d.

To confirm or disprove the absence of stress concentration in fillets designed as described, a model as shown in Fig. 5 was tested in tension. Conforming to the modified profile described, it had a straight portion, and then a curved portion, conforming to this special profile extending from B to C. In order to make certain that it was a true reproduction of the hydrodynamic analogy, two additional curves were tested. These two curves designated No. 2 and No. 3 differed from the first one, in that x and y values were multiplied by 2 and 3, respectively.

When the photo-elastic method is employed, interference fringes represent areas of constant stress, so that the interference fringe must follow the edge of the model between the points B and C, if the stress along the entire fillet is to remain constant. Tests of the hydrodynamic profile show that this stress actually follows the profile, while for the modified profiles the stress was found to decrease in going from B to C.

Further tests were made of this constant stress contour for bending loads. In a photo-elastic examination of the free-water jet contour in bending it was apparent that the stress decreased in the direction from B to C, indicating that more material could be removed. By placing the model in the polariscope the interference fringe position was observed on a screen, while material was removed until a constant stress condition was finally obtained.

By this method the contour of constant stress for pure bending was obtained in terms of the values of x for tension, multiplied by the factor E obtained from the curve, Fig. 6. Using these corrected values of x the distance a from the assymptotes is obtained, and the desired contour for bending load can be drawn in.

From a production point of view a radial fillet will be given preference where the part is made or finished by a rotating tool. On the other hand, if the part is cast or machined by a shaper, any shape of contour can in most cases be made readily. This new contour is the best possible one for reducing stresses on fillet material, and can be advantageously used for a number of machine parts and structures.

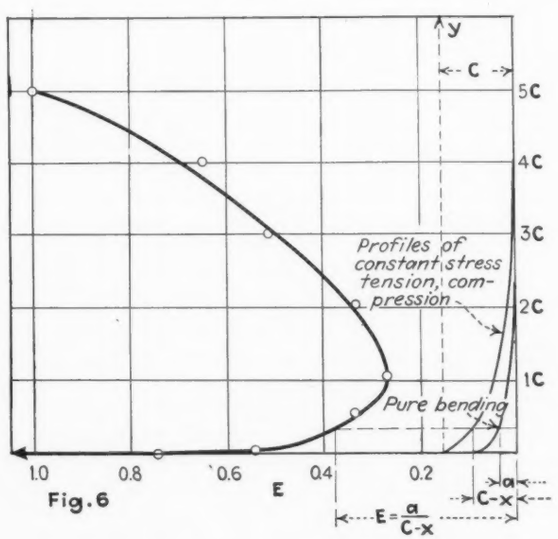


Fig. 6—Ratio E between abscissas of the constant stress profiles for tension and bending were determined by experiment

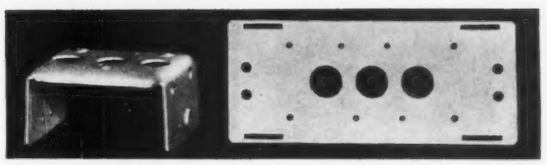
Surface Protection

Durability • Economy • Appearance

LEONARD F. HIRSH
Chemical Engineer, Philadelphia Rust-Proof Company

Photographs Courtesy of *Udylite Process Company*

To avoid unsightly rust this suspension arm for a steel filing cabinet drawer is cadmium plated



Blanks can be cadmium plated and then formed, as shown to left, without injuring the surface

BECAUSE of the simplicity of the processes, one is likely to lose sight of the fact that the type of rust-proofing specified might seriously interfere with the manufacture of the product or even cause a mechanical failure in service. Parts might be of such a shape as to make it difficult or impossible to apply the type of protective coating specified. Or the coating used might call for certain provisions with reference to dimensional tolerances and machined finishes.

Considering the six rust-proofing processes in common use, each has its own general field of application. No one of them is the best for all purposes, although frequently it may be difficult to choose which of two processes may be the better.

In hot galvanizing, the parts are immersed in a bath of molten zinc kept at a temperature of 800 to 900 deg. F. Therefore, items such as thin steel sections will warp and springs dipped in the bath will lose their temper. And because the coating of zinc that clings to the part is not of uniform thickness, galvanized nuts and bolts will not fit together unless special precautions are taken. Either the threads must be recut or a special coarse thread form must be used.

Other difficulties that may prohibit the use of galvanizing are that drilled or tapped holes are likely to be filled with the zinc, exact dimensions cannot be maintained, the coating is not smooth and paint will not adhere to it satisfactorily. Hence galvanizing cannot be specified if a fine finish is required.

One important factor that must be given consideration if the part is to be subjected to stresses, is the effect of the galvanizing process on the physical properties of the material. Galvanizing appreciably lowers the fatigue resistance of the iron or steel that is coated. Galvanized steel cables subjected to repeated bending have been known to fail at loads considerably lower than ungalvanized cables. Cast or malleable iron galvanized caps used on porcelain inserts for high tension insulators are made heavier to compensate for the weakening effect of the hot galvanizing process.

Because of the limitations of the process as outlined above, hot galvanizing is confined to marine hardware, pole-line hardware, and parts not subjected to appreciable stresses, such as structural steel members, tanks and castings. The process cannot be used if appearance must be considered, or the parts must have accurate dimensions, or when the temperature of the galvanizing bath might cause the part to warp.

Sherardizing was discovered in England by Sherard Cooper Coles while he was investigating methods for hardening armor plate. In this process the parts to be coated are packed in a drum with finely divided zinc dust and then heated to about 725 deg. F. At this temperature the zinc sublimes, forming a gas that penetrates into the pores of the metal, the heat having caused the pores to open somewhat. After the temperature has been maintained for several hours the drum is allowed to cool, the zinc vapor condensing in the pores of the metal and alloying with the base metal.

The thickness of the Sherardizing coating is suffi-

cient to cause difficulty when this coating is applied to small nuts and bolts, unless the nuts are tapped oversize. The process is not used on parts of appreciable size because of the limited size of the drums, the largest being about 30 in. diameter and 10 ft. long. Even with such large drums it is not practical to Sherardize large metal parts as the weight of the packed material tends to distort the piece, particularly when heat is supplied to the drum.

Sherardizing is particularly well adapted for castings, forgings and small parts. When oiled or painted, the finish is durable. But if not painted, the dull grayish color of Sherardizing is a disadvantage in this day of "eye appeal."

Zinc plating is, relatively speaking, little used. If done properly it gives a satisfactory rust-proof coating. But deep recesses in the part are likely to receive only a thin coating because of the limited throwing power of the zinc solution. And the color and texture of the finish is not as good as that of cadmium plating, nor is the coating as ductile. For this reason, cadmium plating has gradually replaced zinc plating in many industries.

Cadmium plating solutions have the best throwing power of all plating solutions with the exceptions of tin and silver. However, it is advisable to avoid deep recesses or depressions in the surface to be plated, as these would require the use of "inside" anodes in order to get a uniform thickness of plating. But slight depressions such as screw threads can be plated uniformly and given a sufficient degree of rust protection by a coating so thin that it will not interfere with the fit of the nut.

Another feature of cadmium plating is that the coating is so ductile that the plated sheets can be rolled and formed without injuring the plating. For wire products, the wire can be plated before fabrication. It is also possible to plate sheet steel parts and form them later without injuring the plated surface.

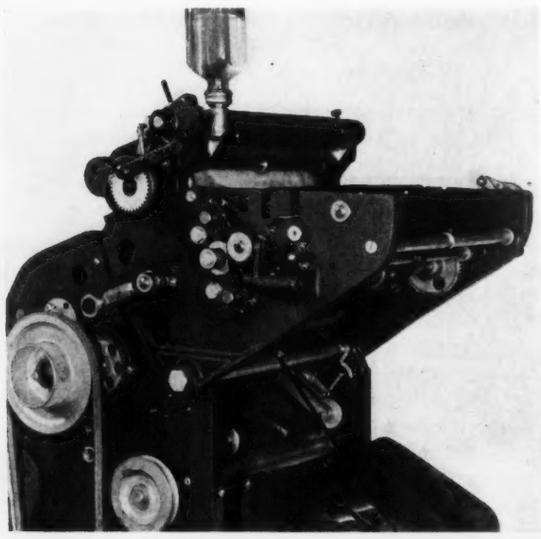
Unlike zinc, cadmium is not soluble in the common alkalies and therefore can be used for washing machine parts and similar applications where the part comes in contact with alkaline solutions. Zinc die-cast parts are often cadmium plated for this reason. Springs can be cadmium plated without becoming embrittled.

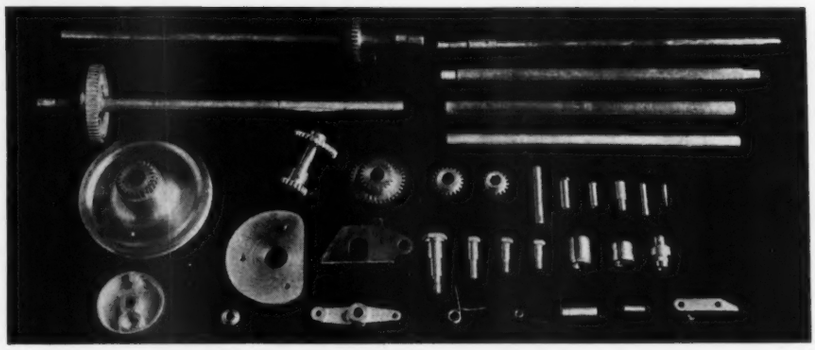
Because of its pleasing silvery appearance, cadmium-plated parts are not painted. As is true of all electroplated surfaces, the degree of surface protection depends on the thickness of the coating.

With reference to the thickness of coating to be specified, for ordinary indoor exposure, the thickness of cadmium required can be judged by the results of accelerated corrosion tests using the salt spray method. This method is described in the *Bureau of Standards* Circular No. 80 "Protective Metallic Coatings for the Rust-Proofing of Iron and Steel." But because of the many variable factors that are encountered in making these tests, it has been found that the results will vary considerably even for the same service conditions. With reference to outdoor exposure, there seems to be no definite relation between the salt spray tests and the outdoor service obtained. This is largely accounted for by the differences in climatic conditions. The tests being conducted by the American Society for Testing Materials show apparently no correlation between the thickness of the coating and the durability of the surface protection.

Typical applications of cadmium plating include automotive parts, screw machine parts, clevices, turnbuckles, springs, radio set panels, screws, nuts, switches, condensers and condenser cradles, parts for washing machines, vacuum cleaners, thermostats, electrical devices, hardware, office equipment and numerous other applications.

Parkerizing is a chemical conversion of the surface of the iron or steel into iron-phosphate compounds. The parts are immersed in the chemical bath for about an hour and a half, which completes the operation. During the process, gas bubbles are evolved from the chemical reaction and if the article is so designed that gas will pocket in any particular spot, that particular





Above—The latest model of the Multigraph-Addressograph Company. All of the white-appearing parts are cadmium plated. To the right are shown some of the other cadmium-plated parts that are used in this machine

CHARACTERISTICS OF SIX RUST-PROOFING PROCESSES

Name of Process	How Applied	Advantages	Limitations
Hot Galvanizing	Zinc applied by dipping in molten bath.	Cheapness on structural steel, tanks, etc. Coats all over.	Is not good base for paint; heat of molten zinc bath tends to warp materials, make casting brittle and lose its tensile strength; is not smooth nor attractive in appearance; and changes dimensions considerably.
Sherardizing	Zinc applied by baking process.	Cheapness on castings, forgings, and small parts. Coats all over. Tough, wear resisting coating.	Not well adapted to large items; finish not attractive; heat affects springs, lock washers, etc.; process a dirty one to use; changes dimensions slightly.
Zinc Plating (Electro Galvanizing) (Cold Galvanizing)	Zinc applied by electro plating	Cheap. Does not warp parts, or affect threads.	Will not thoroughly coat inside cup shaped products or in pipe; does not generally plate uniformly on threads; finish is not particularly attractive.
Cadmium Plating	Cadmium applied by electro plating.	Good rust-proof coating for many articles; withstands alkalies; solders easily, plates threads uniformly; and a very attractive finish.	Will not plate inside pipe, or deep recesses; does not hold paint well; dimensions increased by only 0.0002 in. approximately.
Parkerizing	A chemical conversion process wherein the parts to be treated are put in a bath.	Easy to apply; inexpensive; excellent base for paint; does not warp or affect springs; does not change dimensions; coats inside and outside; when coat is abraded rust will not spread.	Color black, must be finished with paint, oil or wax. Must be sanded if a high class paint or lacquer finish is to be obtained.
Bonderizing	A chemical conversion process similar to Parkerizing.	Has most of favorable characteristics of Parkerizing, in addition to which it gives a smooth chemically clean surface that is an excellent base for paint or lacquer to secure a fine finish at low cost with minimum rejects.	Used only as a base for paint, lacquer or varnish.

spot naturally will not be coated. Therefore, the designer must make certain that it will be possible to immerse the part in the solution without the formation of gas pockets.

Parkerizing plus a suitable coating applied over it, such as Glyptal paint, or even merely linseed oil, provides an excellent rust-proof coating that can be used on a great variety of items ranging from steel windows and structural shapes, down to typewriter parts. Unlike most of the other processes, Parkerizing does not alter dimensions to any extent and is also an excellent base for paints. It does not warp or affect springs.

Bonderizing is also a chemical conversion process, but is used only as a base for paint or other finishes. For certain applications it has a distinct advantage over Parkerizing, which is really a better rust-proof coating than Bonderizing, but it is more difficult to produce on a Parkerized surface as glossy finish such as is desired on automobile fenders and most consumer products. For such purposes, Bonderizing is preferable to Parkerizing, not only because it is a better base for a high finish, but also because it is more economical.

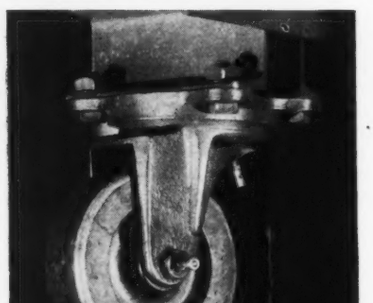
To illustrate the fundamental differences between Parkerizing and Bonderizing, if an automobile fender were to be Parkerized it would have to remain in the bath for about an hour and a half, whereas the Bonderizing process only requires an immersion period of from only five to ten minutes and the surface that is produced by Bonderizing is of such a nature that it produces a glossy surface when the finishing coats are applied. On the other hand, after Parkerizing the coating would probably have to be sanded down in order to secure a glossy finish. For these reasons, the Bonderizing produces not only a better finish, but the rejects in the finishing department are fewer. Indeed, the fact that Bonderizing greatly reduces the number of rejects in the finishing department is usually of sufficient importance to offset to a considerable extent the cost of the Bonderizing process. Also, as the Bonderizing process produces a chemically clean surface which is otherwise difficult to secure, paint or lacquer adheres better and is, therefore, easier to apply. It is for these reasons that the Bonderizing process is so widely used for all parts that are to be given a paint or lacquer finish, and where appearance is an important factor.

With reference to the general question of the application of protective coatings, it has been found repeatedly that the addition of a finish coating of a protective nature to even ordinary drop forgings and castings greatly increases their salability. For example, purchasers of simple castings and forgings sometimes get the impression that they could have these parts made in some foundry to their own pattern. However, when such items are plated or given a protective coating of some kind or other, they look much more like a finished product and the idea of having the items made to their own order does not enter the purchaser's head —or at least not so readily.

(1) Molded plastics have greatly improved the appearance of wiring devices and have permitted more intricate as well as more colorful designs

(2) The cigarette casket is a good example of molded plastics in the packaging and premium fields. Distinctive designs, variety of color and economical production costs are obtainable

(3) Plastic molded truck wheels are rapidly replacing and supplementing the older materials in the industrial fields. Such wheels roll more easily and quietly and resist corrosion



Engineering Data for Designing Molded Plastics—I

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Engineer, Plastics Department, General Electric Company

PLASTIC molding compounds can be divided into two groups, hot-molded compounds and cold-molded compounds. Hot-molded compounds in turn are of two general types: the thermosetting compounds, which become permanently hardened during the molding operation; and those designated as thermoplastic, which can always be softened when reheated. The thermoplastic compounds will soften at temperatures ranging between 60 and 90 deg. C. (140 to about 190 deg. F.). Because of this and the cold flow characteristics of the thermoplastic compounds, they are not widely used for mechanical purposes, but are confined almost entirely to ornamental applications. On the other hand, thermosetting compounds are not affected by even relatively high temperatures (100-150 deg. C. or about 212-300 deg. F.) and have very little cold flow. Because of these two characteristics, the thermosetting compounds are widely used both for mechanical parts and for ornamental application. In view of the limited field of the thermoplastic compounds, only the thermosetting compounds will be considered here.

In comparison with laminated and cold-molded compounds, the hot-molded compounds are best suited for parts requiring good appearance, good mechanical or electrical properties, accurate dimensions, light weight and thin sections. But the hot-molded plastics are not well suited for parts subjected to elevated temperatures, above 300 deg. F., and for this same reason they are not suited for parts that might be subjected to momentary high temperatures as the result of electric arcing. Also, where frequent changes must be made in the design of the part, the cost of changing the mold might prohibit the use of hot-molded plastics. On the other hand, intricate surface designs such as grilling, embossing, lettering or ornamental figures are quite feasible and can be produced economically in hot-molded plastic parts. Another advantage is that metal inserts can readily be incorporated in hot-molded parts, thus providing simplified and improved designs or simplification in the assembly processes.

In the manufacture of hot-molded parts, the usual procedure consists of loading the proper amount of molding compound into the heated mold, closing the mold for a definite length of time, opening the mold and removing the molded part. The molding compound is in powdered or granular form and may be compressed into pellets for convenience in handling. When the heated mold containing the compound is closed, the

compound softens and is forced into every crevice in the mold cavity. The compound then hardens and after proper curing is generally removed from the mold while still hot. Multiple cavity molds are used for the large production of small or moderate size pieces.

Physical and chemical characteristics of the different hot-molded compounds vary widely, no one compound having all the desirable qualities of all of them. Hence, the selection of the particular compound to be used for a given part must be made with the knowledge that certain characteristics can be realized only at the expense of some others.

For general utility, the hot-molded compound is composed of a wood-flour filler with a phenolic-resin binder. The soft, finely divided wood-flour fibers permit easy flowing, and hence makes satisfactory moldings of intricate shapes and the easy production of smooth, polished surfaces without noticeable wear or abrasion of the molds. This material is opaque and can be colored by dyes or pigments, but the presence of the phenolic resin prevents obtaining satisfactory pastel colors.

The mechanical and electrical properties of this material are good. It resists water, oils, weak acids, most solvents, nickel plating solutions and similar corrosive agents. But the material is attacked by strong acids and strong alkalies and because the phenolic resins are readily carbonized by high temperature, the material is not arc resistant. Continual immersion in water results in a slight swelling of the material and a prolonged immersion over a period of approximately a year generally results in disintegration of the material. Intermittent exposure to water has little effect beyond the possible deterioration of the surface finish. Temperatures up to 130 deg. C. or about 270 deg. F., do not affect the material. In Table I are given the physical properties of this wood-flour phenolic-resin material.

Typical application of hot-molded plastics comprised of wood-flour filler and phenolic resin binders include such parts as handles, knobs, supports, meter and instrument parts, terminal switchboard parts, industrial electrical controller parts, radio parts, wiring supply parts, automotive parts, panels, ornamental cases, boxes and similar parts.

Hot-molding compounds using macerated cloth filler instead of wood-flour filler have greater mechanical strength and toughness, but do not flow as readily. Hence this material cannot be molded into as intricate shapes and does not possess quite as good a finish as the wood-flour compound. Other characteristics of the macerated cloth filler compound are the same as the wood-flour filler compound, as shown in Table I.

Typical applications of the macerated cloth filler compounds include parts for switchgears, industrial controller parts, cases and other parts where greater mechanical strength is required than can be furnished by the wood-flour compound. Because the macerated cloth-filler compound has a strength intermediate between that of the wood-flour filler compound and die-castings, this molding compound has a greatly extended field of use for all applications where strength is a factor.

For increased heat resistance, up to temperatures of about 150 deg. C. or about 300 deg. F., and for better water resistance and a lower temperature coefficient of expansion, a hot-molding compound with an asbestos filler is used. The asbestos filler causes greater mold wear and abrasion and results in a somewhat poorer finish than the wood-flour filler. And this material is heavier than the wood-flour or fabric filler. But the asbestos-filler compound is superior to the wood-flour or fabric filled compound in its resistance to low-power arcs, and hence is suitable for applications such as dis-

TABLE I—PROPERTIES OF PLASTIC MOLDING COMPOUNDS

COMPOUND	COLOR and FINISH	Water Absorption per cent 48 hr.		Heat Resistance (Deg. C.) (Approx.) Temperature up to which not affected physically	Compressive Strength Lb. per sq.in.		Flexural Strength (Modulus of Rupture) Lb. per sq.in.		Impact Resistance (Charpy) (ft.-lb.) Unnotched specimen 5″x½″x½″		Dielectric Strength Volts per mil 100 deg. C. in oil. Step-by-step test thickness 0.2 in.		Density Lb. per cu.in.
Hot-Molded		**Avg.**	**Max.**		**Min.**	**Avg.**	**Min.**	**Avg.**	**Min.**	**Avg.**	**Min.**	**Avg.**	
Wood-flour filler, phenolic-resin binder	Black, brown, medium brown, light brown, maroon, red (scarlet), dark blue, dark green, walnut, mahogany—Glossy	0.50	0.55	130	14,000	16,000	9,000	10,000	0.65	0.72	40	60	0.050
Fabric filler, phenolic-resin binder	Black, brown—Glossy	0.50	0.55	130	30,000	31,000	9,500	10,000	0.90	1.20	40	60	0.050
Asbestos filler, phenolic-resin binder	Black, brown—Glossy	0.07	0.10	150	16,000	17,000	8,000	9,000	0.38	0.40	50*	70*	0.067
Cellulose filler, urea-formaldehyde-resin binder	Natural, ivory, white, primrose yellow, Chinese orange, tomato red, orchid, pink, lettuce green, cornflower blue—Glossy	0.45	0.51	100	19,000	21,000	9,500	10,500	1.00	1.05	60	90	0.053
Cold-Molded													
Asbestos filler, asphalt and drying oil binder	Black, brown—Dull	1.5	2.0	250	11,000	12,000	4,000	5,300	0.38	0.40	40	60	0.072
Asbestos filler, asphalt and resin binder	Dark brown—Dull	2.0	2.5	250	15,000	17,000	6,500	7,500	0.38	0.40	40	60	0.072
Asbestos filler—inorganic	Gray—Dull	12	15	700	15,500	16,500	4,500	6,000	0.55	0.60	Variable, depending upon absorbed moisture		0.079

*Thickness, 0.125 in.

tributor heads, heater connectors, meter frames, small motor molded commutators and similar application. Table I includes the physical properties of the asbestos filler hot-molding compound.

In addition to the fillers enumerated, there are other fillers which are used to meet certain conditions such as for example, high dielectric strength and low dielectric losses, for which a mica filler is used. This material is heavier and mechanically weaker than the wood-flour material.

Of the other synthetic thermosetting resins, urea-formaldehyde resins are important. Urea-formaldehyde resins can be molded in all colors, including white and pastel. This is obtained by the use of special cellulose filler. The compound is quite similar to the wood-flour phenolic compound except for the greater variety of

TABLE II

Commercial Tolerances for Hot-Molded Plastic Parts at Minimum Cost

These tolerances are only for dimensions that are not dependent upon the closing of the mold, alignment of wedges or other movable parts. They do not apply to overall dimensions.

Nominal Dimensions (In in.)	Tolerances above and below Nominal Dimensions (In in.)	Nominal Dimensions (In in.)	Tolerances above and below Nominal Dimensions (In in.)
¼	0.003	5	0.015
½	0.005	6	0.015
1	0.008	7	0.020
2	0.010	8	0.020
3	0.012	9	0.020
4	0.015	10	0.025

available colors, lower heat resistance (100 deg. C. or 212 deg. F.) and its higher impact resistance. The urea-formaldehyde resin has a fair arc resistance for low-power arcs, is resistant to oils, water, solvents, and weak acids, but is attacked by strong alkalies and strong acids. The material is not suitable for use in outdoor applications because of its tendency to warp or check upon atmospheric exposure, with accompanying brittleness. In general this material will not mold satisfactorily in thick sections. Typical applications include wall panels, plugs, dials, wiring supply parts, clock cases, novelties, cosmetic containers and similar parts. Table I includes the physical properties of this material.

Because full consideration must be given to economical shop practice in the production of molded parts and also to the securing of maximum reliability, best results in the design of the molded part can be secured only through close cooperation between the engineer and the producer of the part. The designer must determine the requirements as to physical strength, operating temperature and electrical properties required, and he must proportion the part accordingly. This must be done with a proper consideration of the properties of the material selected.

The information given here will aid in the designing of the parts and will serve for general guidance. But since there are many designs to which this specific information is not strictly applicable, an application engineer familiar with the application and operating conditions, and an engineer representing the producers of the molded part should always be consulted for the approval of the design and the compound selected. This should always be done before the design is placed in production, as it is often possible to change certain details in such a way as to simplify and improve the part with a consequent saving in the cost of the mold and the finished part.

Data given here on the properties of the molded materials were obtained from standard A.S.T.M. tests made on standard A.S.T.M. test specimens. For the comparison of one compound with another, average values are given. Minimum values are given for such properties as transverse strength, dielectric strength, and similar properties. For such properties as the rate of water absorption, maximum figures are given. In using the data on the properties of molded material, it is of utmost importance that certain general characteristics be always considered. These include:

1. Effect of thickness of section. In general, as the thickness of the section is increased the transverse strength and the dielectric strength per unit area decrease.

2. Effect of operating temperature. In general, as the operating temperature is increased the mechanical strength and the dielectric strength decreases. For this reason the dielectric strength at 100 deg. C., or 212 deg. F., is given in Table I. In most applications in which dielectric strength is an important factor the operating temperature is likely to be nearer 100 deg. C. than room temperature. Molded compounds which have

A group of mechanical and electrical parts showing how plastics can be molded in a variety of forms—simple or intricate, with or without metal inserts

high dielectric strength at 100 deg. C. will have high dielectric strength at room temperature, but the reverse of this is not always true.

3. Effect of long time loading. When the compounds are subjected to repeated shocks, their impact resistance decreases. The impact fatigue limit after 200,000 impacts is approximately 30 per cent of the single-blow impact resistance. Dielectric strength decreases with increase in the length of time that compounds are electrically loaded. An instantaneous or short-time dielectric strength test gives the highest dielectric strength. A step-by-step test gives lower values and hence is of more significance to designers. The maximum dielectric strength at which compounds can be continuously operated is lower than the values obtained by step-by-step tests.

As in the case of cast-metal parts, the properties of plastic molded parts are greatly affected by their design, so that in general the properties exhibited by test specimens of simple shape will not be realized with more complicated pieces.

An exact calculation of working stresses is impracticable because of the many uncontrolled variables.

Good design of molded parts is, as with other materials, a question of exercising proper judgment as to the strength of the compound, and the application of a suitable factor of safety to be used with conservative values of the physical properties of the compound. It is recommended that a factor of safety of not less than five for mechanical and not less than ten for dielectric strength be used.

Many surface designs such as grained leather, stipples, knurls and similar effects can be obtained by machining the mold surfaces. Where no design is specified, the smooth surface is supplied. Obviously, surface designs cannot be used on certain of the mold surfaces, that is, those surfaces where the indentation on the surface would prevent the withdrawal of the molded part from the mold.

Exacting requirements on smooth flat surfaces, such as high luster or a matte finish, necessitate extra operations such as buffing, polishing, or rubbing, which operations correspondingly increase the cost of the finished part.

A properly designed, well-built mold is absolutely necessary for the production of satisfactory molded parts. Molds are made from high-grade steel, hardened, ground and polished by skilled toolmakers.

In order to take full advantage of the economies of molding and to hold mold costs, labor, inspection and losses to a minimum, it is imperative that proper consideration be given to dimensional tolerances. Variations in dimensions are bound to result from the customary tool-room tolerances in the construction of the mold, uncontrollable distortion during mold hardening, gradual wear of the molds, variations in shrinkage of different batches of compound, and dimensional variations, depending on the molding technique. To manufacture molded plastic parts with extremely close tolerances requires greater care and precision in both the making of the mold and the production and inspection of the finished parts. This results in substantially higher cost.

In Table II are given tolerances which give satisfactory molded parts at a minimum cost and these tolerances can be used for general applications. They apply in particular to such dimensions as the center to center distance between holes and other dimensions that are determined by fixed dimensions in the mold. But depending upon the size and shape of the part, these tolerances may not be applicable to such dimensions as those determined by the closing of the mold and those dependent upon the alignment of wedges or other movable parts, nor may the tolerances be applied to over-all dimensions.

Occasionally it may be absolutely necessary to have accuracy greater than the tolerances given in Table II. For such requirements, minimum tolerances are given in Table III. Except where shrink fixtures can be used to hold extremely accurate dimensions, tolerances closer than those given in Table III should not be specified. It is obvious that in the interest of lowest cost of parts, only those close limits required for the proper functioning of a part should be specified, and those limits should not be specified closer than absolutely required. Where such tolerances are necessary the limit to be worked to should always be specified, as for example:

For a critical outside diameter, specify a plus tolerance of zero and the allowable negative tolerance.

For a critical inside diameter, specify the dimension with the allowable plus tolerance and a negative tolerance of zero.

The tolerances given in Table III apply to fixed mold dimensions. Additional tolerances are required for dimensions dependent upon the closing of the mold. These so-called "build-up" tolerances which must be added to the tolerances as given in Table III are, on single cavity molds, plus and minus 0.005 in. Greater "build-up" tolerances are required on multi-cavity molds.

Careful consideration of the design and location of holes in molded parts is necessary to insure minimum trouble and delay in the molding operation. Since the pins forming holes wear comparatively rapidly and are relatively fragile, a poor design or close tolerances result in the necessity of frequent replacement of worn or broken pins. As these pins are made to the maximum allowable size and replaced when worn to the minimum, large tolerances tend to insure long pin life.

TABLE III
Minimum Tolerances for Molded Plastic Parts

These tolerances apply only to dimensions that are controlled by fixed dimensions in the mold.

Nominal dimension (In in.)	Tolerances above and below nominal dimension (In in.)
0.500 or less	0.002
0.500 to 2.000	0.005
2.000 or over	0.0025 per in.

For holes in the direction of molding there are certain pin proportions which, in general, are not practiable to exceed. These proportions are, of course, influenced by the flow condition as determined by the shape of the piece and the location of the pin. For blind holes the maximum ratio of hole length to hole diameter varies linearly from 1 for a diameter of $\frac{1}{16}$ in., to 2 for a diameter of $\frac{1}{2}$ in. For through holes made either with two pins butting in the center or one pin entering the other member of the mold the ratio varies respectively from two to four. A hole near the edge of the molded part should generally have a minimum side wall not less than one-half the hole diameter. Where two pins butting in the center are used to form a hole, in order to compensate for any misalignment it is desirable that one pin be at least 0.020 in. larger than the other, particularly on multi-cavity molds.

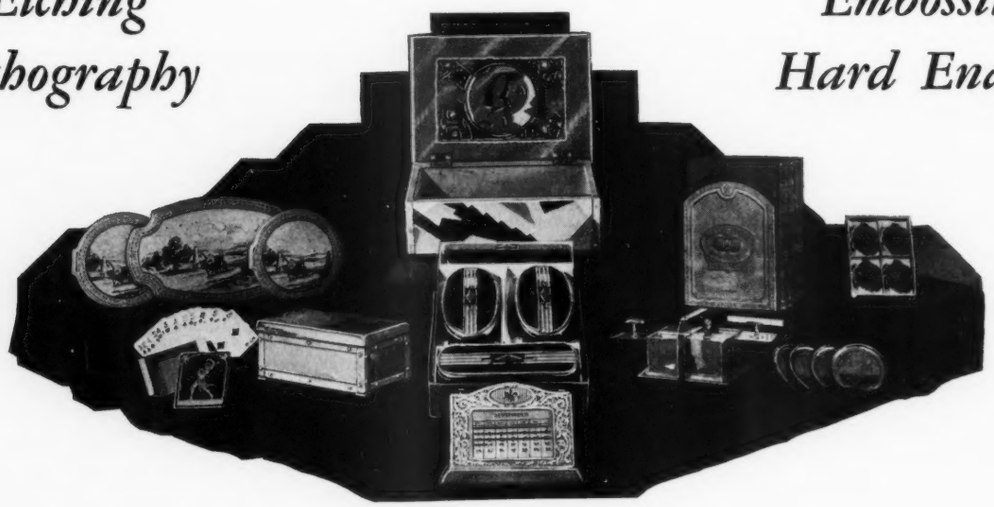
Cross holes are holes at right angles to the direction of molding and necessitate special types of mold construction to permit the withdrawal of the pins forming the holes. Because of the increased cost of mold construction and because of the added molding operation, it is frequently cheaper to drill such holes after molding. Where long cross holes are required, some additional support must be furnished the pin. Pins supported on both ends can have a maximum length of two and one-half times the pin diameter. On cross holes that must exceed these dimensions, usually a center supporting pin must be used. Frequently, by the use of slots or indentations in the molded part, cross holes can be eliminated. In general, oblique holes should never be used if they can be avoided.

Four Economical Processes for the Decorative Finish

FRED WEINDEL, JR.
President, L. F. Grammes & Sons, Inc.

Etching
Lithography

Embossing
Hard Enamel



IT IS well recognized that in the field of consumer goods, the appearance of the product will exert a tremendous influence on its sales record. And the same psychological reactions that affect the salability of consumer goods come into play in the sale of industrial equipment. It is not to be inferred that products such as steam rollers or mill machinery should be given a "nickel plate finish." Such treatment would be out of place and would look absurd. But lack of attention to the appearance of details such as name plates, instruction plates or emblems will give an impression of makeshift design.

Coupled with art in metal products, another requirement is permanence. One of the outstanding features of the processes described here is their durability, which impression they convey to the product they adorn.

The type of lithographing on metal described here must not be confused with the ordinary lithographing that is put on tobacco cans and similar containers where art is often overlooked and cost of producing is the prime consideration. By the modern art of lithography a fine degree of artistry can be produced. For quantity production, lithographing on metal costs less than any of the other processes described herein. And the severe wear and tear to which signs, displays, dials and the like are subjected is often such that lithography on metal is the only practical answer.

Likewise, lithography on metal is not confined to any one kind of metal. It can be done successfully on steel, tin, zinc, aluminum, brass, nickel silver or stainless steel. Meter and clock dials are usually lithographed on zinc or aluminum because of the corrosion resistance and non-magnetic properties of these metals.

Etching is a process whereby a piece of metal is chemically engraved to reproduce a design. For quantity production, the design is put on the metal by a printing process, using an ink that is inert to the etching acid. The pieces are then immersed in a solution which eats into the unprotected surfaces of the metal. The depth of etch depends on the length of time that the parts remain in the etching solution.

Practically every type of metal can be etched, the most common ones being brass, bronze, aluminum, zinc, nickel silver, stainless steel and some grades of ordinary carbon steel. Regardless of the metals used, etching can be combined with embossing, enameling and electroplating. Etched aluminum is often colored by the anodic treatment. Intelligently applied, rich and pleasing effects can be obtained.

Etching is also widely used for clock and instrument dials such as shown in the accompanying picture. It is not only the most dependable method for making name plates, but through the application of colored effects and modern designs it has found a big place in objects of art and gift merchandise. The jewel chest shown in the center of the illustration at the head of this article is an example of etching combined with colored enamels. The set of brushes shown below the chest is an example of etching and enameling combined with chromium plating. The set of table mats at the

left of this is an example of etching done in the half tone process, reproducing a pictorial design.

One of the features of etched work is the sharpness of outline and detail that is obtained. Etched name plates are, without question, the most permanent as well as the most economical type of plate. This is especially true where plates are exposed to wear. And when an extra measure of character and fineness of design is wanted etching proves a most adaptable process.

There has been vast progress in the embossing of metal during the past few years. A new process has been developed for embossing metal as thin as 0.0005 in. Such embossed plates are called "metal labels" because adhesive is put on their back for attaching them in the same manner as labels. They have been used on high class packaged goods, furniture, radios, jewelry and in fact, on most merchandise where a quality atmosphere is desirable.

In the heavier types of embossed plates unusual effects are obtained by filling the sunken areas with colored free flowing enamels, or giving the plate an oxidized and relieved finish, or sprayed bronze finishes in a myriad of effects. The General Electric name plate shown here illustrates such treatment.

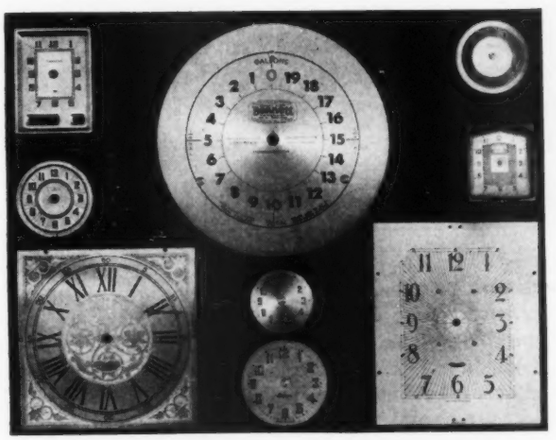
A combination of embossing together with drawing permits unusual effects in bezels, at greatly reduced costs over other methods. Embossing is also used for medallions wherein a modeled design is formed out of a heavy piece of metal. Many medallions, such as are used on the Graham Paige automobile, are die struck. In this process the metal is squeezed up into die which is modeled in reverse, leaving a bold, solid metal impression. Not all metals can be embossed readily, and the height or depth of die struck embossed work is limited by the design or area to be covered. For this process, the metal is required to be from $\frac{1}{8}$ to $\frac{1}{4}$ in. thick or more. Embossing, unless one goes into a tricky finish, is comparatively inexpensive for large run production.

Hard enameling is one of the oldest methods of decoration known to mankind and embodies the finest and most durable method of embellishing metal with permanent color, whether it be a name plate, an emblem, a piece of jewelry or a gift article.

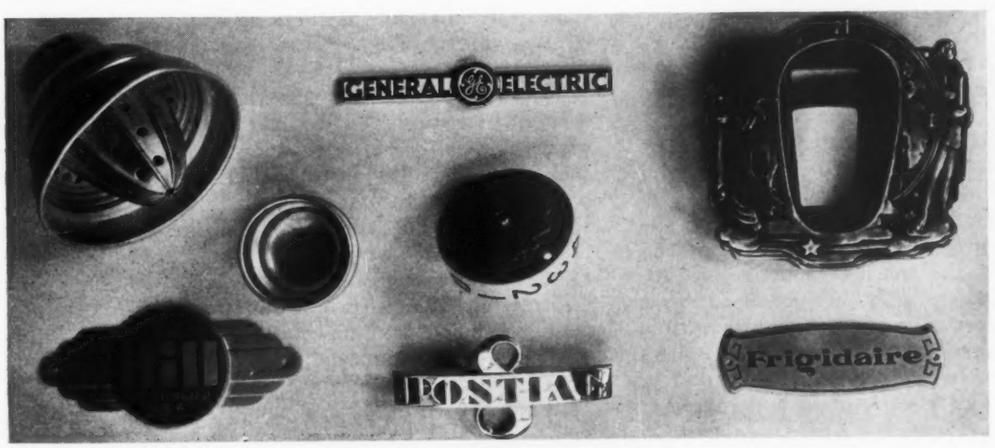
Hard enameling consists of fusing ground colored glass to a suitable alloy of metal. A temperature of about 1,600 deg. F. is required. Once fused, the enamel flows and spreads as does solder, presenting a smooth glass surface. The article can then be plated or polished in any manner desired. Since hard enamels are provided in transparent as well as opaque colors, the beautiful effects of transparent colors over a striped or textured background leaves much opportunity for real art, especially as might be applied to industrial uses.

Of recent years, hard enamel has found a wide field in auto radiator emblems and instrument panels, lapel buttons, better types of name plates, cigarette lighters, compacts and similar products. The rare and durable beauty of a hard enameled article cannot be matched by any other process.

The manufacture of items incorporating the types of finishes described here is highly specialized. It therefore requires one who is thoroughly versed in the latest and most efficient methods of producing such metal products to select the best process and make the article strong enough, attractive enough, and economical enough to exactly fit the need. Since the cost of most of these articles usually forms an insignificant percentage of the cost of the equipment they are to go on, it pays to get the service of a company whose recommendations are based on the results of much research for the benefit of the people whom they serve.



The clock dial in the upper left corner is etched, lithographed, embossed and drawn. The other dials are examples of the use of one or more of these processes



The numbered meter wheel in the center is a lithographed aluminum alloy (Nicral). The bezel is an excellent example of the combination of embossing and drawing, while the name plates are combinations of embossing and enameling

Give Motor Manufacturers A Chance to Recommend

WHEN the designer supplies the motor manufacturer with complete information before the design of the machine has reached the detailing stage, unnecessary correspondence and loss of time are usually eliminated, development and experimental costs are often reduced, and a satisfactory motor is obtained without repeated trials. To assist the designer in supplying complete information necessary for selecting the most suitable motor for the application, the "Inquiry Form" shown on the opposite page was prepared with the cooperation of fourteen leading motor manufacturers.

Selection of a suitable motor before tools or patterns are prepared often results in saving in development costs. In an instance reported by one motor manufacturer, "The built-in main-drive motor in the base of an automatic slicing machine did not give satisfactory starting conditions. A special elongated motor, designed to fill all the space available, was satisfactory only under average conditions, and left no margin of capacity to meet severe conditions of operation. To provide more space for the motor the pattern for the base casting had to be changed."

Another manufacturer writes, "With the motor mounted on the drill spindle of a vertical drilling machine, the diameter of the motor frame limited the minimum center distance between multi-spindle units. When a ventilated motor housing was replaced by a fully inclosed housing to keep out dust and dirt, trouble developed from excessive motor temperature. A larger diameter motor was found to be necessary, and expensive modifications in the design of the drilling unit had to be made to accommodate larger center distances."

In another instance, "A designer asked for a ½-hp. universal motor to fit within a diameter of 4⅜ in., supplying no information regarding the driven machine. The motor manufacturer supplied a motor developing ½ hp. at 7,500 r.p.m. The high-speed motor was direct-connected to a 12-in. diameter circular wood saw, and was completely inclosed with no provision for ventilation. This motor proved to be unsatisfactory. The right motor finally selected had a lower operating speed, was well ventilated and also much larger."

Where sufficient information on the motor application is given to the manufacturer, the use of a motor especially developed for the machine may result in considerable saving. The designer, in such instances, obtains satisfactory performance and service life without paying for unnecessary power, speed or size, and in addition the designer has a better opportunity to utilize all the advantages of electric drive and control.

It has evidently been the experience of motor manufacturers that many engineers will not make the necessary effort to give the required information. In the opinion of some motor manufacturers: "This form (given here) seems to be complete, but we doubt whether many engineers would have the patience to fill it out completely." . . . "Some of our engineers are skeptical as to anyone's ability to educate motor buyers to consider all necessary points." . . . "If we used a form as complete as this one, most prospects would construe that we were too much trouble and would buy elsewhere." . . . "It is impossible in many instances to secure a fair amount of this information without personal contact by one of our engineers."

Admittedly, filling in the chart will require some thought and care. But to take full advantage of the experience of the motor manufacturer, information on each of the items in the check list is necessary. Several manufacturers in commenting on this Inquiry Form state, "The list covers all the essential facts that the motor manufacturer must know to advise what type of motor should be used." . . . "If the information called for on this form were obtained, the motor manufacturer would have much better information than is ordinarily given." . . . "Answers to even 10 per cent of the form would help." . . . "The inquiry form is very complete and we would do well to use this form in the future."

• Frequently engineers fail to give complete data and information when making inquiries for electric motors. The fourteen representative motor manufacturers listed here comment on this situation. They also collaborated in the preparation of the Inquiry Form given on the page opposite

Allis-Chalmers Mfg. Co.	**General Electric Co.**
The Louis Allis Co.	**Holtzer-Cabot Electric Co.**
Baldor Electric Co.	**Ohio Electric Mfg. Co.**
Black & Decker Elec. Co.	**Signal Electric Mfg. Co.**
Century Electric Co.	**Star Electric Motor Co.**
Delco Products Corp.	**Wagner Electric Corp.**
The Dumoré Co.	**Westinghouse Elec. & Mfg. Co.**

INQUIRY FORM FOR ELECTRIC MOTORS

INQUIRY FROM.....

ADDRESS.....

BY.....

1. Name of machine to be driven.....

2. Field of use.....

3. Estimated quantity, initial order.....first year.....

4. Power Supply
   - (a) Direct current.....volts
   - (b) Alternating current.....volts,.....phase,.....cycles
   - (c) Universal motor.....volts
   - (d) Will power supply vary?

5. Motor speed and direction of rotation
   - (a) Full-load running speed.....r.p.m.
   - (b) Allowable variation ±.....per cent of full-load speed
   - (c) Direction of rotation, from end opposite shaft extension, clockwise....., counter clockwise....., reversible.....
   - (d) Is a multi-speed motor required? Give speeds....., ..., ...
   - (e) Adjustable speed motor, speed range.....to.....

6. Running load requirements and conditions. Load determined by test....., obtained from present practice....., or estimated..... (For multi-speed motor give following data for each speed):
   - (a) Continuous load.....hp.
   - (b) Intermittent load.....hp.
     - (1) length of time at full load.....min.
     - (2) idle running.....min., time at rest.....min.
     - (3) maximum momentary torque.....lb.—in.
   - (c) Fluctuating load
     - (1) magnitude of overloads.....hp.
     - (2) duration of overloads.....min.
     - (3) frequency of occurrence.....
   - (d) Reversing service
     - (1) reversals per min.....
     - (2) time intervals on.....min., off.....min.
     - (3) inertia of load.....

7. Starting Load
   - (a) Torque, starting....., accelerating.....
   - (b) Is motor started under load?....., or without load?.....
   - (c) Type of unloading device.....
   - (d) What is the inertia of the load including couplings, pulleys, gear drives or flywheel?.....
   - (e) Speed of driven element..... r.p.m.
   - (f) Drive: direct....., gear....., belt....., chain..... Type of coupling if direct drive.....

8. Space available for motor
   - (a) Restricted to a maximum diameter of.....in.
   - (b) Restricted to a maximum length of.....in.

9. Motor Mounting
   - (a) Vertical....., horizontal....., oblique.....
   - (b) Foot mounting at end....., below....., above....., flange mounting..... Special (show by sketch)
   - (c) Resilient mounting.....
   - (d) Is mounting position of the motor changeable?.....

10. Motor Housing
    - (a) Motor exposure: outdoor....., indoor.....
    - (b) Within machine or housing, partly inclosed....., totally inclosed..... (Give dimensioned sketch of housing and show ventilation provisions)

11. Condition of Ventilating air
    - (a) Presence of dust....., grit....., moisture....., steam..... corrosive gases....., oil vapor....., explosive gases....., salt air....., other contamination.....
    - (b) Maximum temperature of cooling air.....deg. F

12. Requirements as to quietness of operation. Explain.

13. Bearings and Lubrication
    - (a) Manufacturers standard.....
    - (b) Motor to be lubricated at intervals of.....
    - (c) End play restricted.....; thrust loads present.....
    - (d) Type of bearing preferred
      - (1) Sleeve: lubricated by oil ring....., waste.....
      - (2) Ball; lubricated by oil....., or grease.....

14. Shaft extension: single..... or both ends.....; if vertical, up..... or down.....; straight..... or tapered.....
    - (a) Diameter.....in., length.....in.
    - (b) Pulley fastened by setscrew....., key.....
    - (c) Keyway dimensions: standard....., or special, width.....in. depth.....in. length.....in.
    - (d) Can the design be made for standard shaft dimensions?.....

15. Weight limitations if any.....

16. Electrical Control
    - (a) Hand....., automatic....., remote.....
    - (b) Motor protected against overload....., under voltage.....
    - (c) Is limit switch used.....
    - (d) Are brakes used.....

17. Electrical Leads
    - (a) Manufacturer's standard.....
    - (b) Special leads: number....., length.....
    - (c) Attachment cord: length....., plug.....

18. Give special requirements such as special insurance regulations, dynamically balanced rotor, etc.

Additional copies of this Inquiry Form suitably printed for use in making inquiries can be obtained free of charge upon request to the editor

COMMUNICATION and COMMENT

Lubricant Circulated Without a Pump

P. H. TRICKEY
Small Motor Engineering Division
Westinghouse Electric & Manufacturing Company

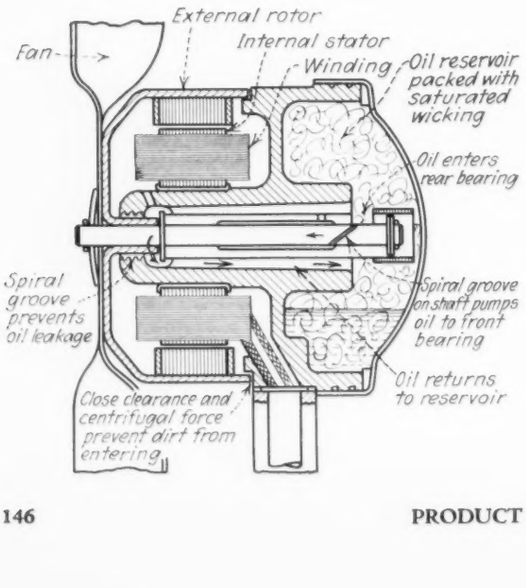
Fan motors for refrigerators are designed to meet two requirements, low energy consumption and freedom from servicing. The unusual lubricating system of the motor shown in the illustration is sealed within the motor, enough oil being supplied so that the motor never needs attention. In this design, oil is fed from the reservoir to the shaft by a wick through a window cut in the bearing. A spiral groove in the shaft serves as a pump and takes oil from the wick at the rear window and forces it to the front bearing. After the oil passes through the front bearing, it drops by gravity into the groove at the end of the bearing and runs down through the oil return passage to the reservoir. There it is absorbed by the wick and again is pumped through the bearings. The oil reservoir contains 55 c.c. of oil, more than is usually supplied to a motor with bearings of twenty times the area. Loss of oil may take place by wearing out, evaporation, spilling or leaking. With continuous oil flow and a cool-running motor, loss of oil by the first two ways is negligible.

Because refrigerator crates may be shipped in almost any position, the oil chamber is so designed that there is no position in which the oil can run out of the reservoir. Since the motor operates in a horizontal position, there is only one possible opening for oil leakage, the place where the rotor hub enters the oil path. At this point in the housing a spiral oil groove is provided with close clearance between the rotor hub and the oil groove, so that rotation of the shaft forces the oil back along the groove into the oil return. Oil leakage at the reservoir cover is prevented by a design using a tight press fit, cement filled grooves and a heavy paper gasket. Breathing vents are provided to allow for expansion and contraction of air in the reservoir.

With this system of lubricant circulation and the provisions against loss of oil, the fan can run during the life of a refrigerator without attention, a conservative estimate of the motor life being from ten to fifteen years.

To reduce the power consumption of the motor, the design incorporates an unusual electrical construction. Ordinarily, a low cost induction motor is built with a wound primary on the outside, and the squirrel cage rotor on the inside. Advantage has been taken of the construction of this oiling system to invert the electrical parts, placing the primary on the inside to obtain shorter windings and less electrical losses. By the use of machine-wound primary coils this capacitor-type motor can be built at a cost competitive with the shaded-pole motor. Because of the shorter leads and the fact that the capacitor motor is inherently more efficient than a shaded-pole motor, the new fan motor requires only one-half the input of the usual shaded-pole motor—14 to 16 watts instead of 25 to 35 watts.

The motor develops about 1/250 hp. running at 1,250 r.p.m., and supplies enough air to cool a refrigerator normally driven by a $\frac{1}{8}$ or $\frac{1}{6}$ hp. compressor motor. However, it can be designed to operate at any speed between 1,400 and 1,000 r.p.m., and its winding can be designed to operate on 50 or 60 cycles, for voltages below 125 volts.


External rotor
Internal stator
Fan
Winding
Oil reservoir packed with saturated wicking
Oil enters rear bearing
Spiral groove prevents oil leakage
Spiral groove on shaft pumps oil to front bearing
Oil returns to reservoir
Close clearance and centrifugal force prevent dirt from entering

To eliminate the necessity of periodic oiling, the Westinghouse refrigerator fan motor has grooves in the shaft to cause circulation of the lubricant

Efficiency of Draftsmen

J. R. SHUSTER
East Orange, N. J.

In measuring the working efficiency of draftsmen, the principal handicap is the variety of work a draftsman is called upon to perform and the divergent conditions under which the work is done. In organizations where there are a number of draftsmen doing work similar in character it is not difficult to compare results, and thus measure relative efficiency. However, in most drawing rooms the work is varied and an accurate basis for comparison is difficult to obtain. In drawing rooms where the work is done by a relatively small force under direct supervision, there does not seem to be any need for an elaborate system of records to indicate the relative output of each draftsman.

When it is desirable to use a tangible unit of measurement, it is necessary to turn to the only tangible output of a drawing office—drawings. In highly standardized work it has at times been found possible to establish a standard time system and actually produce drawings on a piece-work basis of pay.

But in most drawing rooms the draftsmen are called upon to perform such constantly varying duties that a piecework system cannot be applied.

One system, now in operation, divides drawings into a number of classes based on size, content and character of workmanship needed. A "par time" is established for each class of drawing and this par time compared with the actual time required to produce the drawing. One disadvantage of this system is that it is necessary to rely upon personal judgment in assigning the drawing to its class.

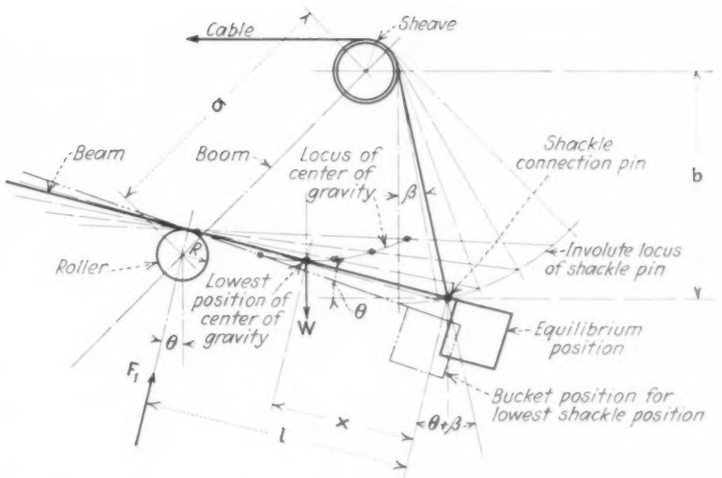
In another system, now in operation in an organization including twelve to fifteen draftsmen, the performance of the entire group is considered as a unit, while the performance of the individual draftsman is subjected to the judgment of the supervisor. Since the character of the work done does not vary greatly from time to time, it has been possible to establish an "average" time for an "average" drawing. The number of drawings produced by the entire group is compared with a figure obtained by dividing the total number of man hours worked by the "average" hours per drawing. Although this system cannot be used to check results from day to day, it works out very well over longer periods of time.

Unless working conditions and class of work produced are nearly similar, it does not seem practical to make any direct comparison of performance between individual draftsmen or between groups of men. Because of the great differences in working conditions and in classes of work that do exist, cold figures do not offer a logical comparison of relative efficiency. After all, the average executive knows where the weakest links in his organization are, without the necessity of consulting an elaborate set of records.

Using a Mirror in Design

JOHN E. HYLER
Peoria, Ill.

In the development of bisymmetrical designs a piece of silvered glass with one straight edge can often be of assistance. With a few experimental lines lightly sketched as one side of the design, the complete design approximately as it would appear in bisymmetrical form can be seen simply by holding the mirror perpendicular to the paper in the position of the center line of the design. By turning the mirror to different angles and moving it to various center line positions, many ideas and possibilities can be developed that would otherwise escape attention. This method saves time by reducing false starts, mistakes and erasures, and many times designs can be made more pleasing to the eye simply by selecting the proper axis of symmetry.



Because of the variables in the structure, forces on the dredge beam can be determined with sufficient accuracy by this graphical method

Forces on a Dredge Beam

To the Editor:

Two factors are involved in the problem submitted by K. F. Cossaboon on page 71 of the February number. First, the determination of the position of rest for a body having one degree of freedom, and second, having found this position, the determination of reaction at the beam supports. When terms derived from a general solution of the first part are inserted into the reaction equations, all expressed in terms of the unknown, a very complicated situation is produced. Because of all the variables involved such an analytical solution will be of little practical value.

For example, the center of gravity of the beam, bucket and load, may or may not lie in the lower face of the bucket beam, thus the equilibrium position will be affected. Also, friction in the roller support will affect the beam position, the influence increasing directly as the ratio of roll shaft to roller diameter. If the radius of the roller is neglected and the beam considered as always passing through the intersection of the roller circle and center line of the boom, the effective span of the beam will be reduced and the roller reaction correspondingly increased. Since the nearest commercial sizes of raw stock would obviously be used in construction, regardless of the size demanded by a rigid stress analysis, the following graphical method is the most practical solution to problems of this type.

As shown in the accompanying diagram, the center line of the boom, and roller and sheave circles are laid out approximating the dimension b. After laying out a series of beam positions, the center of gravity of beam, bucket and load is found for different positions, and the locus drawn in. Since the system is stable, this curve will be upwardly concave, the lowest point of the curve being the position of rest under gravity. After the equilibrium position is found the normal to the roller at contact is established and the cable line drawn from the shackle pin tangent to the base circle of the involute.

The supported beam length l, the beam angle θ, and the cable angle β are scaled from the drawing. From the scaled quantities and the given conditions, the roller reaction F_1, and the cable tension F_2, are:

$$F_1 = \frac{Wx}{l} \cos\theta;\ F_2 = \frac{W(l-x)\cos\theta}{l\cos(\theta+\beta)}$$

This graphical method will give a sufficiently accurate solution for the two forces considering the variables that are involved.

—R. V. HOPKINS
Lansing, Mich.

Worm Gear Efficiency

To the Editor:

Recognized authorities are silent regarding the variation of coefficient of friction with pressure angle. The information given in the chart on page 2 of the January *Product Engineering* is based on personal experience in connection with a large number of tests conducted over a period of years. However, this chart can be used only when the loads are applied under identical conditions. The worm speed also has an important effect as the efficiency increases with the speed. Perhaps the values given should not have been shown as "coefficients of friction," as the factors contain not

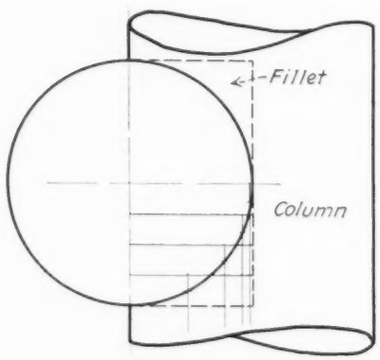
only the power lost in sliding friction, but also the losses caused by bearings. However, the values do represent the observed over-all efficiencies, and have served as a basis for guaranteed efficiency specifications in a large number of instances.

In one instance involving a ratio of 60 to 1, other designers guaranteed efficiencies as high as 80 to 90 per cent, while information on which the table is based indicated an efficiency of only 60 per cent. Customers' tests on designs submitted with high guaranteed efficiencies showed actual efficiencies of from 42.5 to 57 per cent, whereas the unit guaranteed for 60 per cent actually showed 61 per cent efficiency. Because of a number of experiences along this line, the author feels that the table given in the article is reliable in indicating that the coefficients of friction vary with the pressure angle. —C. H. GRILL
Ridley Park, Pa.

Volume for Intersecting Cylinders

To the Editor:

The following graphical method gives an approximate solution for the interference volume of two intersecting cylinders as requested by Floyd Carlson in the February number, page 70. Referring to the accompanying figure, the volume within the dotted line is $0.3927\ d^3$ representing the intersection of a square section with the round column. Since the proportion of the fillet volume to the whole volume is constant, the required interference volume can be found readily after determining the fillet volume.



A graphical method for determining the interference volume is given by Mr. Craven

In a large scale layout one of the four equal fillets is divided into several elements. The approximate volume of each of these elements is found by scaling the layout, giving for the total of all four fillets 23.8 per cent of the total volume included within the dotted lines. The required interference volume is, therefore, 76.2 per cent of $0.3927\ d^3$, or $0.295\ d^3$ for the two intersecting cylinders. —ARTHUR A. CRAVEN
Marion, Ohio

To the Editor:

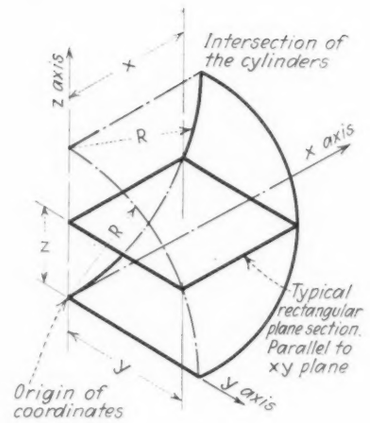
In the accompanying diagram one of the four interference zones are shown. The volume of its shape is the limit of the sum of a series of rectangular laminations of thickness dz. When x and y are expressed in terms of R and z the total volume is obtained from the third equation given below the diagram. The expression under the integral sign may be handled by dividing R along the z-axis into an even number of equal parts, numbered from 0 to m. For the nth ordinate the area of the cross section is:

$$x_n\ y_n = R^2 \sqrt{\frac{2n}{m} - \frac{n^2}{m^2}}\ \sqrt{\frac{m^2 - n^2}{m^2}}$$

Integration for approximate volume may then be executed by such approximate methods as Durand's or Simpson's rules. Using Simpson's "one-third" rule, and multiplying by 4 to obtain the entire interference volume, the entire interference volume V, becomes:

$$v = 2.293\ R^3$$

Errors contained in this expression arise from the approximation in the integration process, and from the use of a slide rule for the tabular work. The method of approach is old, and for general purposes the order of accuracy is satisfactory. — R. L. TURNER
New York, N. Y.



$$x = \sqrt{2Rz - z^2} \qquad y = \sqrt{R^2 - z^2}$$

$$V = \int_{z=0}^{z=R} \sqrt{2Rz - z^2}\ \sqrt{R^2 - z^2}\ dz$$

Values for x and y as given in the first two equations are used in the third equation, obtaining the volume V by integration

Parts from Seamless Steel Tubing

ROLAND V. HUTCHINSON
Lansing, Mich.

In determining the maximum outside diameter and the minimum inside diameter to which commercial cold-drawn seamless steel tubing can be machined to give a completely clean surface, one is likely to become confused in making allowances for various standard tolerances. By means of the accompanying table the minimum bore and maximum outside diameter for any size of cold-drawn seamless steel tube can be determined readily.

Dimensional tolerances on cold-drawn seamless tubing cover ovality, straightness, and wall thickness. The tolerances specified by the Army specifications are in agreement with

TABLE I
Standard Tolerances for Seamless Tubing

Nominal outside diameter, D...	up to 1½ in.	1½ to 3 in.	over 3 in.
Tolerance in outside diameter, d	+ 0.005 in. − 0.000 in.	+ 0.010 in. − 0.000 in.	+ 0.015 in. − 0.000 in.
Nominal inside diameter, B...	less than ½ in.	more than ½ in.	
Tolerance in wall thickness, t	± 0.15 T	± 0.10 T	
Ratio of wall thickness to diameter, T/D	less than 0.04	more than 0.04	
Ovality tolerance, v	± 0.015 D	± 0.0075 D	

ordinary commercial practice and representative of commercial dimensional tolerances. For thin wall tubing, the tolerances specified by the Air Service depend on the ratio of nominal wall thickness to nominal outside diameter. If the ratio is less than 0.04, the permitted ovality is 1½ per cent of the diameter; if the ratio is greater than 0.04, the permitted ovality is ¾ per cent of the diameter. Straightness is specified as within 1 part in 600, corresponding to 0.040 in. indicator run-out in the mid-length of a piece 1-ft. long.

The mean outside diameter is the average of the maximum and minimum diameter of any transverse section. Tolerances for the nominal outside diameter are graded in three classes, all with no negative tolerance. For diameters less than 1½ in., the plus tolerance is 0.005 in.; for 1½ to 3 in. outside diameter the plus tolerance is 0.010 in.; from 3 in. up to 5½ in., the plus tolerance is 0.015 in.

Wall thickness in any cross-section may vary arbitrarily with nominal inside diameter. A variation of plus or minus 15 per cent of the nominal thickness is allowed for inside diameters of less than ½ in.; if greater than ½ in., the variation allowed is plus or minus 10 per cent. Thus the permissible eccentricity of the bore in relation to the outside diameter is determined by a combination of the ovality tolerance and the wall thickness tolerances. All three tolerances, ovality, diameter and wall thickness, are summarized in Table I.

Machine finishes on parts made from steel tubing usually involve one of the six classes given in Table II. If the finished dimensions call for parts made from seamless drawn tubing, the outside diameters should not be specified to exceed those obtained by the relations as given in the table. Similarly, bores must not be specified smaller than those obtained from the table.

Light-weight alloy tubing is drawn to different dimensional tolerances than those used for steel tubing, so that the figures given in the accompanying table do not apply to dimensioning parts from these light alloys.

TABLE II

Diameters to Which Cold-Drawn Seamless Tubing Can Be Machine Finished

Condition	Maximum Finished Outside Diameter	Minimum Finished Inside Diameter
Outside cleaned up		
Without regard to concentricity with bore.	$D - \frac{1}{2}v$	
If concentricity with bore is required....	$D - \frac{1}{2}v - 2t$	
Bore cleaned up		
Without regard to concentricity with bore.		$D + d + \frac{1}{2}v - 2T$
If concentricity with outside diameter is required		$D + d + \frac{1}{2}v - 2(T-t)$
Finished Inside and Outside		
Without regard to concentricity with bore.	$D - \frac{1}{2}v$	$D + d + \frac{1}{2}v - 2T + t$
Bore concentric with maximum finished outside diameter obtainable	$D - \frac{1}{2}v$	$D + d + \frac{1}{2}v - 2(T-t)$

D = nominal outside diameter d = tolerance in outside diameter
T = nominal wall thickness t = tolerance in wall thickness
v = ovality tolerance

Questionnaire Not for Dairy Equipment Manufacturers

To the Editor:

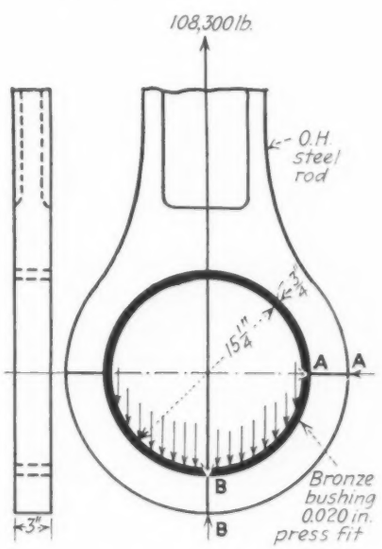
Questionnaire methods discussed in the article "Discovering Customer Preference" in the March number, while suitable for the wide market for automobiles, are not suitable for the limited field of dairy equipment. In our own organization additions to our manufactured line and additions to our distributed line present two distinct problems. Before adding the product of another manufacturer to our line, samples are sent out to our sales organizations, and direct customer reaction obtained from a few selected customers.

With products of our own manufacture the situation is different. New models are not brought out every year, and when new models are being developed the fact is kept secret, as far as possible, until a formal release is made all over the country with proper advertising. If our customers received a questionnaire, they would anticipate that a new model was contemplated and would slow up buying. On one particular survey we did use the questionnaire method, using an advertising agency so as not to reveal our identity. Although we received some interesting data as a result, the limited number of replies did not give a fair cross-section of opinion. —A. H. BARBER
Secretary
Cherry-Burrell Corporation

Design of a Connecting Rod

To the Editor:

In the connecting rod design shown in the accompanying figure, a bronze bushing is pressed into the bore with a press fit of 0.020 in., and the axial load on the rod is 108,300 lb. What will be the dimensions of the section at *A* and *B*? —HENRY BOHN
Schenectady, N. Y.



What dimensions will be required for sections *A* and *B* in this connecting rod design?

Typical Designs of Lock Bolts

ADAM FREDERICKS

This is the first of two installments setting forth 25 designs of various types of lock bolts for hand operated, semi-automatically or automatically operated stops for indexing or similar other purposes

Fig. 1—In the simplest type of rotating stop, the lock bolt bottoms in a hole in the rotating member.

Fig. 2—A conical lock bolt on which the top and bottom of the conical end is milled off at *A* and *B* to allow for wear in the directions of both arrows. The sides take the rotative thrust of the lock bolt plate. Greater life and seating accuracy is obtained as the bolt advances deeper into its seat by milling off the conical ends at *A* and *B*. The bolt must be prevented from rotating.

Fig. 3—In this design the bolt is slid in and out of engagement and clamped by a screw backed brass shoe *A*. The sides of the slots *B* in the plate are ground, being relieved at the bottom, while the open end is bell mouthed or chamfered.

Fig. 4—A bracket *A* bolted to the base casting acts as a guide for the cone ended cylindrical lock bolt and as a retainer for the operating spring which pushes against pin *B* to force the bolt to seat itself firmly.

Fig. 5—When the conical ended bolt is pulled out and twisted 90 deg., it will be kept out of engagement by pin *A* dropping into the shallow slots *B-B*.

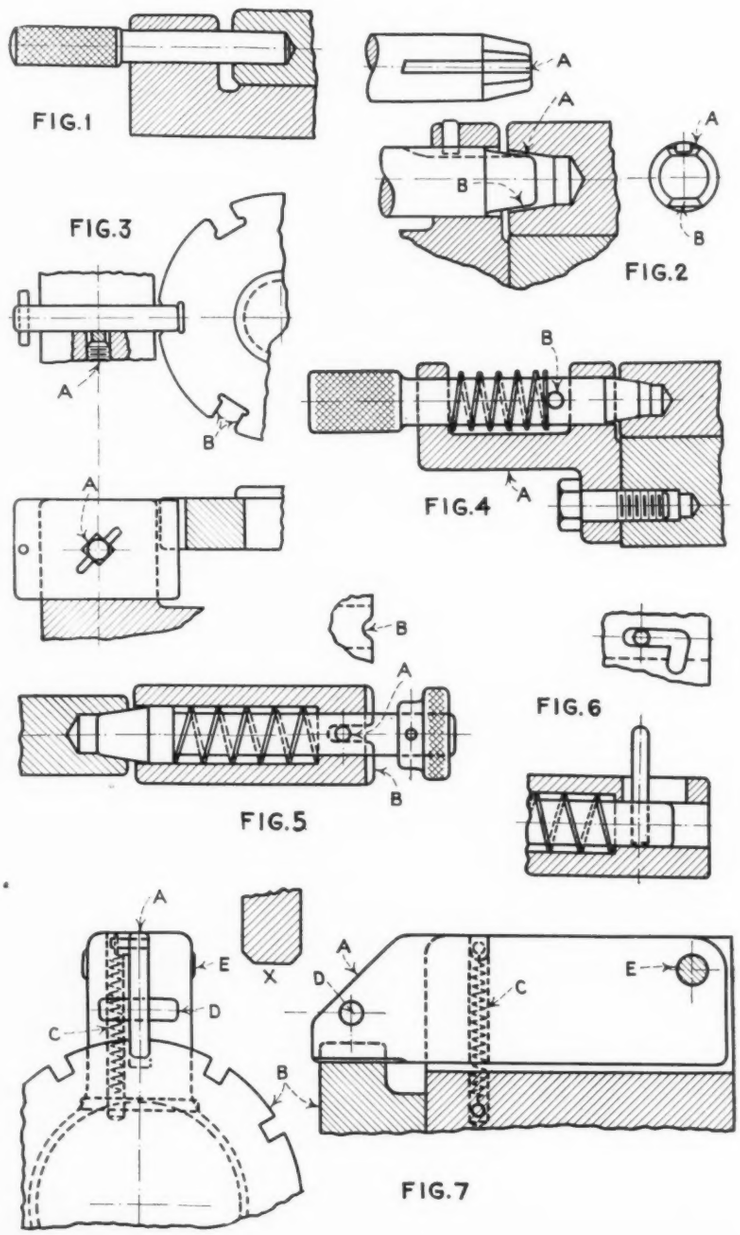
Fig. 6—In this design, the locking bolt is kept out of engagement by a bayonet slot.

Fig. 7—The flat-ground piece *A* acts as the lock bolt, resting against the bottom of the square slot in the lock bolt plate *B* and pivoted at *E*. Spring *C* keeps the bolt engaged. Pin *D* is the handle with which the bolt is disengaged. At *X* is an enlarged view of the engaging end of the bolt.

Fig. 8—The lock bolt is operated automatically by a cam actuated gear segment engaging rack teeth in the bolt. The $\frac{1}{16}$-in. clearance shown between the roller and the cam *A* is to allow the spring to push the bolt firmly into the lock bolt plate slot. In the design shown here the spring is placed to one side of the center of the bolt.

Fig. 9—The rectangular lock bolt *A* is milled out centrally to accommodate the spring which rests against a flattened pin *B*. The bolt is retained by a flat plate *C* and is hand actuated by pin handle *D*.

Fig. 10—When the lock bolt plate is smaller than the piece on which it rotates, the edges of the slot should be chamfered. This eliminates the shaving action which might cause little chips to lodge on the lock bolt seat and result in inaccuracy in locating.



for Indexing Mechanisms—I

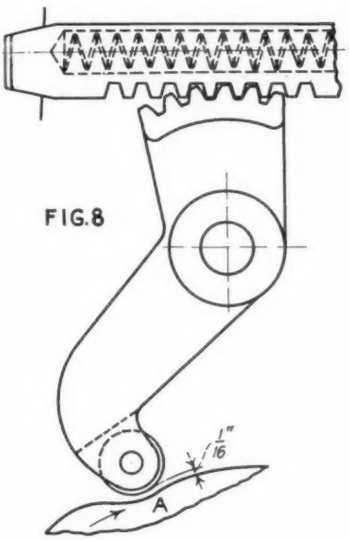


FIG.8

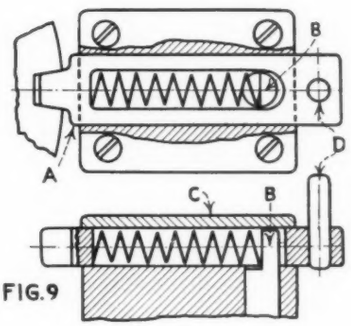


FIG.9

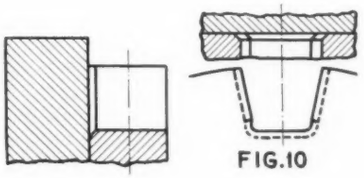


FIG.10

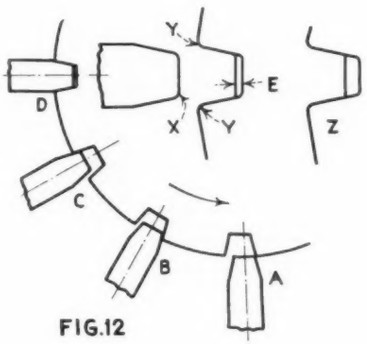


FIG.12

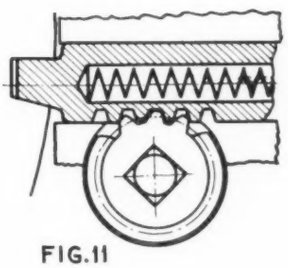


FIG.11

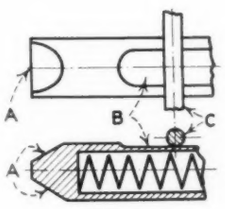


FIG.14

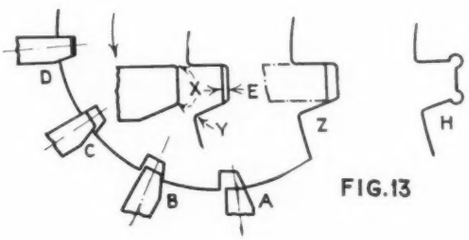


FIG.13

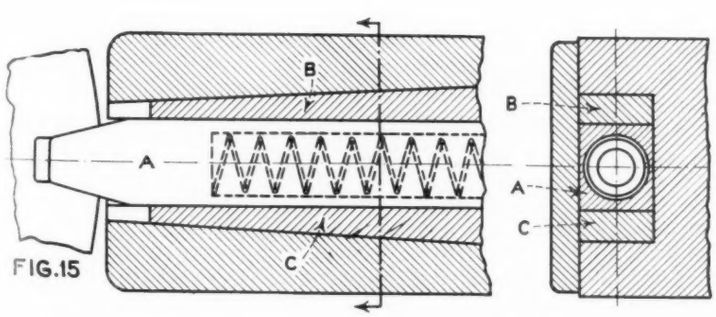


FIG.15

Fig. 11—This rack-and-pinion operated lock bolt does not require accuracy of machining as is required of design shown in Fig. 8. But it does not contain the automatic feature as it is hand operated with a wrench or crank handle.

Fig. 12—In this design, when indexing starts the lock bolt is released and rides on the periphery of the plate. At point *A* it starts to slide down the inclined slot. At *B* is shown the shearing or wearing action that takes place. In case the plate has overrun or indexed past its position as at *C*, the spring behind the lock bolt is required to turn the plate, together with the whole rotating mass attached to it, backwards, resulting in wear on the side opposite to that shown at *B*. At *D* complete engagement is shown. Rounded corners as at *X* and *Y* should be provided. There should be plenty of clearance as at *E* to allow for wear because of the small angle of the slot. At *Z* is shown an improved form of gear. It assures clearance and provides for grinding of the angular surfaces if necessary. If the lock bolt spring is not strong enough to seat the bolt by rotating the plate, vibration will usually complete the seating, causing chatter at the cutting tool or spindle and wear on the bolt and slot. In this type of bolt the angular sides are alike, hence the direction may be opposite from that shown.

Fig. 13—A more accurate form of lock bolt which is claimed by many to be the correct method for this type of design. One side is radial and the other angular. The inclined surface gets the wear as it seats the bolt, while the straight or radial side positions the bolt accurately. Positions *A*, *B*, *C* and *D* are correspondingly the same as in Fig. 12, indicating that the corners *X* and *Y* should be rounded. At *H* is shown how the groove is ground. Other notations are the same as given in Fig. 12.

Fig. 14—When a round lock bolt must not be permitted to rotate in order to maintain the position of a milled end such as shown at *A*, and if the wall of the bolt above the spring pocket is not sufficiently thick for a keyway, a small flat *B* can be cut on the bolt. A pin *C* will prevent rotation of the bolt.

Fig. 15—In this design the bolt *A* is adjusted in both side directions by the tapered gibs *B* and *C*, so that the bolt can be set accurately. This feature makes it possible to position the indexing accurately even if the position of the lock bolt plate cannot be adjusted.

· NEWS ·

Stroboscope Used to Study Spindle Action

Inferior quality of product is obtained when the spindles on a spinning frame, twister or similar machine do not all rotate uniformly and at the same speed. In order to observe the action of the spindles, engineers of the Franklin Rayon Corporation use a stroboscope. This not only shows differences in the speed of the various spindles but also makes it possible to study the action of the spindles individually. It is reported that highly satisfactory results have been obtained through this application of the stroboscope. Undoubtedly the information obtained from such studies will compel manufacturers to strive to improve their machines to overcome the shortcomings as revealed by the stroboscope.

Standards for Graphical Symbols Now Available

New standards covering graphical symbols for Electric Power and Wiring, Radio, and Electric Traction and Railway Signaling are now printed and can be obtained from the American Standards Association. Symbols for certain pieces of apparatus are different in the three divisions, and are printed in italics to indicate that they are not approved as American Standard. In a later revision of the three standards it is expected that many of the differences will be eliminated.

Graphical Symbols for Electric Power and Wiring (Z10g2-1933) comprise those used for diagrams of electric power apparatus, instruments and relays, maps and connection diagrams. With few exceptions, only basic symbols are included for apparatus usually encountered in electric power engineering. While not all types of equipment are covered, relatively small additions to the basic symbols are expected to accommodate variations found in practice.

Graphical Symbols Used in Radio (Z10g3-1933), developed in cooperation with the Institute of Radio Engineers, includes 50 symbols for tubes, transformers, condensers, inductors and other radio apparatus.

Graphical Symbols Used in Electric Traction, Including Railway Signaling (Z10g5-1933) includes nearly 500 symbols, although many included in former standards were eliminated. These symbols are intended for use on one-line diagrams of multi-phase a.c. systems or on complete wiring diagrams for d.c. or single-phase a.c. circuits.

Platinum-Rhodium Alloys Withstand High Temperatures

Electrical resistance heating units made from a platinum-rhodium alloy can be operated at a temperature high enough to melt pure platinum, according to J. S. Acken in a paper, "Some Physical Properties of Platinum-Rhodium Alloys," appearing in the *Bureau of Standards Journal of Research* for February, 1934. The author finds that the addition of rhodium, although increasing the cost, decreases the temperature coefficient of resistance, and thermocouples using this alloy can be operated at higher temperatures than heretofore obtained with other materials. The paper includes complete data on the melting point, density, hardness, oxidation resistance and electrical resistivity.

Aeronautic Division Reorganizes

Because of a growing realization that the field of aeronautics is affecting and is being affected by developments in many other branches of engineering, the Aeronautic Division of the American Society of Mechanical Engineers has been reorganized to offer greater facility in the interchange of ideas and information. This reorganization provides for representation from all fields of engineering related to aeronautics, and also establishes a liaison between the machine design committee of the Machine Shop Practice Division and the Aeronautic Division.

To effect this cooperation with other fields of engineering in the exchange and dissemination of mutually serviceable information, there has been appointed a general Advisory Group composed of W. H. Carrier, Carrier Engineering Corporation, to represent the ventilation industry; Luis de Flores, consulting engineer, representing the petroleum industry; Oliver Allen, Aluminum Company of America, representing diesel engines; William B. Mayo of the New York Shipbuilding & Dry Dock Company, representing marine engineering; L. F. Moody, consulting engineer for the Baldwin Southwark Corporation, representing hydraulics; L. K. Sillcox, vice-president of the New York Air Brake Corporation, representing the railroads; and T. F. Wickenden of the International Nickel Company, representing Iron and Steel Industry. George F. Nordenholt, Managing Editor of *Product Engineering*, has been appointed as the representative of the machine design committee of the Machine Shop Practice Division of the A.S.M.E. In addition to the exchange of data and technical information through the medium of this General Advisory Group, closer cooperation with other technical societies and with other A.S.M.E. divisions, has been established.

Printed Designs on Plastics

In addition to mechanical uses, molded plastics are now finding wide application as bottle closures, as shown by exhibits at the First Beer and Wine Show and the Fourth Packaging Exposition. Bottle caps are molded in one piece with a sealing liner inserted. From the displays, it is apparent that full advantage is being taken of the variety of colors, shapes and sizes available in molded plastics.

Serving trays with colored aluminum inserts, or with printed designs using a recently developed ink said to be unaffected by varnish solvents, were also made from laminated plastics.

For corrosion resistance in bottle filling machines tin-coated copper tubing, glass-lined and stainless steel tanks, and filters of asbestos were in general use.

Welded Construction for Boulder Dam Cranes

It has been announced that orders for the 300 ton cranes for handling the huge generators to be installed in the Boulder Dam power house have been awarded to the Harnischfeger Corporation.

These cranes are of the double-trolley power house type, each equipped with two 30-ton auxiliary hoists. Truck bodies and trolley frames will

be of welded construction. Eight electric motors, totaling 380 hp., are used in the bridge drive, the hoist and the hoist propelling mechanism. The span of the cranes will be 64 ft. and the lift 30 ft.

Another Reason for Hollow-Head Screws

Manufacturers of hollow-head screws have advanced numerous reasons for the points of superiority for this type of fastening. But from the engineering department of a New England machine tool builder comes another reason for the use of hollow-head screws that has probably been overlooked by some manufacturers.

In reply to a comment on the fact that he used hollow-head screws almost exclusively on his automatic screw machine, the chief engineer of the tool manufacturer explained:

"Shortly after we adopted hollow-head screws, our shop men began commenting on them. Because of the small size and weight of the wrenches that are used for hollow-head screws, the men found that they could carry readily in their pockets all the necessary sizes of wrenches. This was not possible with standard hex-head bolts, the solid wrenches for which were too large and heavy to be readily carried in the pockets.

"Investigation in the plants of our customers revealed the fact that the maintenance men also preferred the hollow-head screws for the same reason. They never had to stop and look for the required size of wrench, thereby saving considerable time and annoyance."

New Flying Boat Undergoing Tests

The latest creation in planes is the giant Sikorsky four-engine flying boat recently finished for Pan American Airways for South American service, and now undergoing acceptance tests. The first of six ships, three being built by Sikorsky and three by Glenn L. Martin, this plane is capable of making a non-stop flight of 1,200 miles, carrying 32 passengers, a crew of five and 1,000 lb. of mail.

Indicative of the size and power of this new craft, the four engines develop 2,700 hp., wing span is 114 ft. 2 in., length 76 ft. and gross weight 38,000 lb. The wing area is 1,330 sq.ft., which is about 410 sq.ft. less than the present ships in the Caribbean and West Indies service. But because of higher wing loading made possible by improved design, the weight of the new ships when loaded is 4,000 lb. more than the present ships.

To obtain a perfectly smooth exterior skin in order to minimize air resistance, countersunk rivets are used. In this flush riveting process as used for thin sheets, after punching the holes their edges are countersunk by sinking them with a suitable punch. No metal is removed. The corresponding holes in the member to which the sheet is to be fastened are made oversize or machined countersunk, depending on the thickness. Duralumin is used almost entirely for the frame and skin.

A.S.T.M. Reports on Outdoor Weathering Tests

Electroplated and sherardized coatings are reported to be of equal effectiveness but inferior to hot-dipped aluminum and zinc for resistance to weathering in a paper read by C. D. Hocker, before the Regional Meeting of the American Society for Testing Materials, held at Washington, D. C., March 7. This paper, "Outdoor Test Results on Bare and Metal-Coated Ferrous Specimens," also reports that the protection offered by lead coatings varies considerably for different locations. Zinc coatings are stated to last longer than cadmium coatings of the same weight in a paper "The Harmony of Outdoor Weathering Tests," by R. F. Passano. From data given in this paper it is evident that the effectiveness of zinc coatings varies greatly for different locations.

Another investigation sponsored by the Society, reported by C. L. Hippensteel in "Galvanic Corrosion by Contact of Dissimilar Metals," the following metals are rated from best to worst according to susceptibility: nickel, copper, tin, lead, aluminum, zinc and iron. For marine atmospheres, the materials most resistant to corrosion are lead, lead alloys, nickel, nickel-copper alloys, bronzes, and commercial copper, according to W. H. Sinkeldey in his paper, "How Soon Is It Safe to Draw Conclusions?" From the tests reported by this author it is concluded that these non-ferrous materials show a lower resistance to corrosion in an industrial atmosphere than in marine service.

All four of the above papers are printed in full in a preprint issued by the A.S.T.M. for the Symposium on the Outdoor Weathering of Metals and Metallic Coatings.

MEETINGS

Association of Iron and Steel Electrical Engineers—Spring meeting, Ohio Hotel, Youngstown, Ohio, April 12. John F. Kelly, director 1010 Empire Bldg., Pittsburgh, Pa.

Society of Automotive Engineers—Summer meeting, Saranac Inn, Lake Saranac, N. Y., June 17-22. John A. C. Warner, secretary, 29 West 39th St., New York, N. Y.

American Society of Mechanical Engineers — Semi-annual meeting, Cosmopolitan Hotel, Denver, Colo., June 25-29. Calvin W. Rice, secretary, 29 West 39th St., New York, N. Y.

American Institute of Electrical Engineers — Summer meeting, Homestead Hotel, Hot Springs, Va., June 25-29. H. H. Henline, secretary, 33 West 39th St., New York, N. Y.

EXHIBITIONS

National Alliance of Art and Industry—Industrial Arts Exposition, R.C.A. Building, New York, N. Y., April 3-30. Alon Bement, director, 30 Rockefeller Plaza, R.C.A. Bldg., New York, N. Y.

Knitting Arts Exposition — Exhibits of equipment for knitting and allied trades by the National Association of Hosiery Manufacturers, Commercial Museum, Philadelphia, Pa., April 23-27. Albert C. Rau, Manager, 329 Park Square Bldg., Boston, Mass.

Progress in Alloy Cast Irons

Progress in the uses of cast iron for high strength, heat-resistant and corrosion-resistant applications was summarized in a paper read recently before the American Society for Metals by F. B. Coyle, metallurgist of the International Nickel Company. This paper reports compositions and properties of alloys giving increased hardness and resistance to wear and reduced shrinkage.

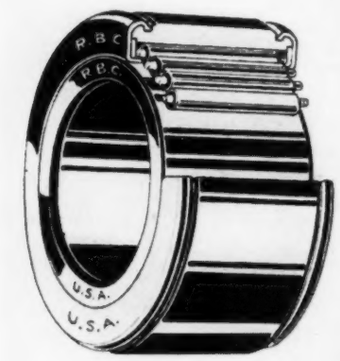
Tables, charts, curves and micrographs are given to show the effect of annealing, quenching and normalizing heat treatments. Alloys for reduced growth and increased corrosion resistance are described, giving composition and representative data on applications. Heat-treatment is shown to increase impact resistance and decrease brittleness.

Copies of Mr. Coyle's 12-page paper, "American Progress in the Use of Alloys of Cast Iron," can be obtained from the International Nickel Company.

NEW MATERIALS and PARTS

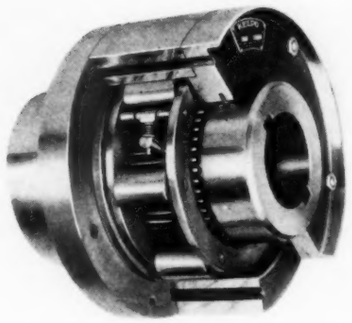
20th Century Solid Roller Bearing

Designed for maximum capacity within minimum space, and for satisfactory performance at high speeds. It is a full type, solid roller, self-contained bearing, has no retainer or cage. Outer race made from hardened and ground SAE 52100 steel. Rollers have trunnion ends retained within outer race by two hardened washers knurled over the ends of the outer race. Hardened steel plates between end rings and ends of rollers are designed to resist wear and locate the rollers. For shafts not adaptable to hardening, bearing is supplied with an inner race of the same material as the outer race. Because of intimate contact of the rolling elements, design is said to minimize churning of the lubricant and generation of heat. Available for shaft diameters from 0.5 to 5.0 in. Roller Bearing Company of America, Trenton, N. J.



Morse-Kelpo Clutch

Positively actuated one-way clutch is free-wheeling in one direction, but drives in the other. Drive shaft is keyed to drive gear in clutch, the gear meshing with a set of cam gears. Outer ring, driven by engagement of cam gears, transmits power to driven shaft. When the drive shaft is rotated in the driving direction, cam gears are rotated engaging the inner surface of the ring and driving the load. Rotation of drive gear in opposite direction withdraws cam gears from contact with ring. When not in motion, springs keep cams in contact with ring, ready to transmit motion without backlash. Said to be unaffected by centrifugal force. Designed for speeds up to 3,600 r.p.m., in a wide range of capacities. Morse Chain Co., Ithaca, N. Y.



Baldor Coupling

Designed to accommodate fairly large misalignments, coupling is said to be self-aligning, vibration absorbing and flexible in all directions. Driving members are of rubberized fabric. End segments riveted to fabric rings are attached to shaft by two setscrews spaced 90 deg. apart. Fabric rings are riveted to the center spider. There are no loose parts. Coupling action is said to be universal, with parts balanced so that coupling spins true, and does not bind bearings. Available in three sizes for bores from $\frac{7}{16}$ to $1\frac{1}{8}$ in.

diameter, transmitting $\frac{1}{3}$ to 3 hp. at 1,725 r.p.m. Baldor Electric Co., 4357 Duncan Ave., St. Louis, Mo.

Temperature Indicator

Designed for original equipment on machines such as die-casting, soldering, molding machines, or for ovens, furnaces or liquid heating baths. Operated by a thermocouple made of No. 6 gage wire, indicator is of the low resistance type with thermocouples directly connected to the instrument. High-torque, sturdy movement is designed to withstand vibration. Available in two standard ranges, 60-800 and 60-1600 deg. F., in an aluminum case $5\frac{5}{8}$ in. in diameter. Larger cases and different temperature ranges

available on special order. Hexagonal case designed so that thermocouple leads may be attached to the top, bottom or either side of case. Russell Electric Co., 334 West Huron St., Chicago, Ill.

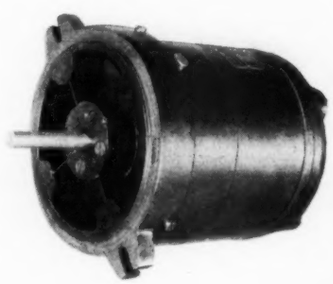
Coin-Operated Time Switch

Designed for connection between an electric refrigerator or similar device and the electric supply, this time switch disconnects the device from the supply line unless periodic stipulated payments are made into the coin switch. The extension cord plug is inserted in a receptacle within the coin switch and is held in place by the locked-on cover. Designed only for

25-cent pieces, coins are credited by inserting them in a slot in the top of the switch and depressing a lever. Up to 15 coins can be credited in advance of use, the number being indicated through a small window. Switch can hold more than 100 coins. Finished in aluminum lacquer, case is $6\frac{1}{4}$ in. high, $5\frac{3}{4}$ in. wide, $4\frac{7}{16}$ in. deep. Available in 115-volt, 60-cycle rating and for other common voltages and frequencies. Standard time interval is 24 hours with other intervals from 6 to 48 hours available. General Electric Co., Schenectady, N. Y.

Resilient Flange-Mounted Motor

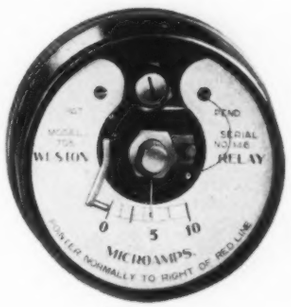
For use in applications where quietness is essential, such as for oil burners using flange-mounted motors. Steel springs used in the resilient suspension are attached radially, providing sufficient rotational motion of the motor frame to absorb torque pulsations without permitting lateral motion of the frame or shaft. Spring mounting can also be arranged to adjust the shaft position to permit alignment with driven shaft. A snubber is incor-



porated to reduce the tendency of the motor to oscillate on starting. Available in ratings of 1/12, $\frac{1}{8}$, $\frac{1}{6}$ and $\frac{1}{4}$ hp., at 1,725 r.p.m.; 1/12, $\frac{1}{8}$ and $\frac{1}{6}$ hp., at 1,140 r.p.m. Other fractional horsepower ratings available as special motors. The Holtzer-Cabot Electric Co., 125 Amory St., Boston, Mass.

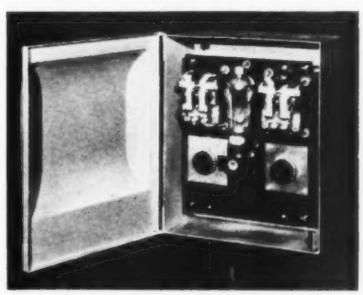
Weston Supersensitive Relay

For industrial controls operated by photo-electric cells, thermocouples or other low energy sources, this relay will make contact on currents as low as 3 microamperes, or on potentials as low as 1 millivolt. Relay is essentially a contact-making indicator, and can be used as an over-voltage or over-current, or an under-voltage or under-current control. Also available with two contacts that may be positioned manually or automatically. Scale indicates values of current, voltage or temperature, so that contact can be adjusted to open or close at any desired point. Case is $3\frac{1}{4}$ in. in diameter, either flush or surface mounting. Contacts are rated at 5 watts, 110 volts, non-inductive load. Designated as Model 705. Weston Electrical Instrument Co., Newark, N. J.



Electronic Timer

For such operations as timing of spot welding machines, X-ray timing and other applications requiring a readily adjustable time delay, device measures out a pre-set length of time and closes or opens its contacts. Time interval is initiated by an impulse from a pushbutton, foot treadle or cam operated switch. The time interval is preset by means of a coarse and a fine adjustment, and can be adjusted from



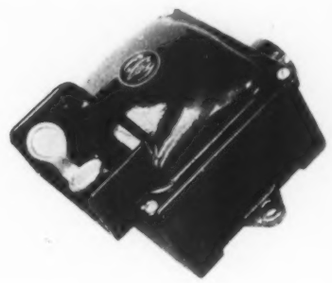
0.10 sec. to 45 sec. Industrial grid-glow tube operates the contactors directly without intermediate relays. Device can be modified to eliminate time errors in the closure of contactors by the use of an auxiliary contact starting the time interval when the contactor closes, instead of when the control switch is closed. Contactor is rated at 10 amp. 115 volts and 5 amp. 220 volts a.c. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Rock Wool Insulation

For use where extreme moisture conditions prevail, material is fireproof, resilient, and waterproof. Special waterproof treatment is said to toughen the fibers, the finished product floating indefinitely. Thermal conductivity is claimed to be 0.265 B.t.u. per sq.ft., covering capacity per ton approximately 2,500 sq.ft. to a thickness of 1 in. Said to be suitable for temperatures ranging from 450 to minus 60 deg. F. Supplied in loose, granulated or nodulated form in 40 lb. bags. Standard Lime and Stone Co., 2004 First National Bank Bldg., Baltimore, Md.

EC&M Pushbutton

For remote control of automatic motor starters, device illustrated is vapor-proof and dust-tight, and em-



bodies a lock-out mechanism. Designed for 3-wire low-voltage installations where it is necessary to start and stop a motor through its controller from two or more pushbutton stations, any one of which can prevent operation of the motor. Padlock inserted on the stop side of any one pushbutton station will prevent operation of the motor. The Electric Controller & Mfg. Co., 2705 E. 29th St., Cleveland, Ohio.

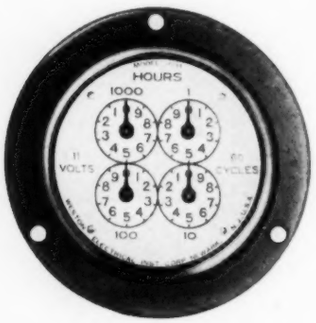
Low-Energy Contact Switch

Requiring less than $\frac{1}{2}$ in.-oz. to operate, can be used at speeds up to 400 contacts per min. For use in operating electrical counting devices or for control of pilot relays, solenoids or motor controls. Contact points are rated at 1 amp. 115 volts, and 0.5 amp. at 230 volts. Contacts are silver-to-silver. Switch mechanism contains but one

moving part encased in a molded bakelite case, with an outlet in the base for a $\frac{3}{8}$-in. BX connector. Designated as type ES-4. Production Instrument Co., 1315 S. Wabash Ave., Chicago, Ill.

Weston Hour Counter

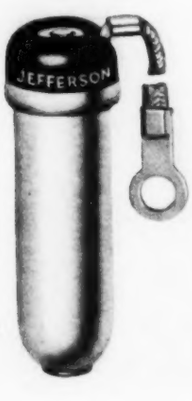
For obtaining the total running time of electrically-operated machines or vacuum tube devices, counter is driven by a ball-bearing, self-starting synchronous motor drawing less than 2 watts. Pointers are driven through an



indicator train of cut gears. Supplied in a flush type bakelite case having a flange diameter of $3\frac{1}{2}$ in. and a body diameter of $2\frac{3}{4}$ in., also in cast aluminum housing for front-of-board mounting. Device weighs 1 lb., 2 oz., is $4\frac{1}{2}$ in. deep. Available for 110-volt 60-cycle circuit, and also for 11-volt supply for connection in parallel with power tube filaments. Weston Electrical Instrument Corp., Newark, N. J.

Jefferson Mercury Switches

Containing no glass or fragile material, the mercury is inclosed within an outer casing of a special alloy which is said to resist amalgamation with the mercury. Metal casing is given a corrosion-resisting outer surface, and in some types is insulated with a molded bakelite shell. Metal casing forms one contact; other contact is mounted in a shock-resisting porcelain insulator, and has a stem which forms a binding post. The insulator is designed so that mercury-to-mercury contact is obtained. To quench the arc and cool the parts, casing is filled with an inert gas under pressure. Mercury switch is said to withstand hard usage without danger of breakage, and to be unaffected by storage. Available in three types: with grounded outer shell and one lead, same with two leads, and with insulated outer shell with two leads. Supplied in two capacities: 15 amp. a.c., 7 amp. d.c., 125 volts; 10 amp. a.c., 5 amp. d.c., 125 volts. Also available for 250-volt service. Switch is approximately 2 in. long, $\frac{1}{2}$ in. in diameter. Jefferson Electric Co., Bellwood, Ill.



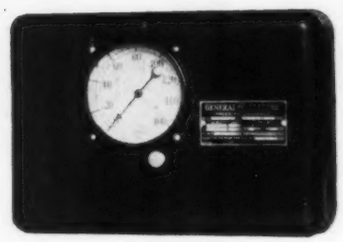
Speed Nuts

Designed to replace an ordinary nut and lock washer, is said to provide a more effective and permanent means of assembly. Replacing the conventional nut, a punching of high carbon spring steel is pushed over the projecting end of the screw, thereby holding it in place. Fastenings can then be tightened with a screw driver without the use of a wrench. Prongs at the

corners of the punching prevent rotation during tightening. Available in a number of shapes, and supplied in any special shape or form desired. Tinnerman Stove & Range Co., 2038 Fulton Road, Cleveland, Ohio.

General Electric Pressure Governor

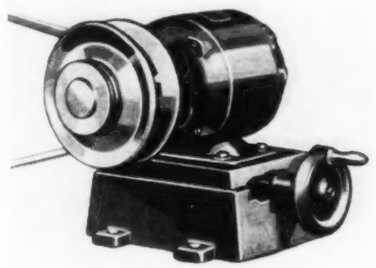
For maintaining a predetermined pressure in industrial processes. Can be adjusted to operate at any point between 20 and 80 per cent of the full scale rating, with a maximum differential of 60 per cent. Minimum differential is 2 per cent of the full scale rating, with the accuracy at any setting



1 per cent of the full scale. Approximately 10-in. high, 14-in. wide, 5-in. deep. General Electric Co., Schnectady, N. Y.

Variable Speed Pulley

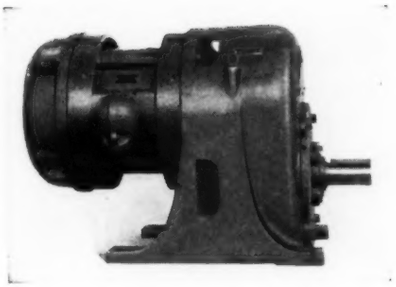
Consisting of two conical sections or two half-pulleys having slots on their conical faces allowing them to interlock, and giving a cog or positive drive effect to the variable speed pulley. When mounted on the shaft of a motor, the two half-pulleys will move together or separate as the base of the motor is moved back and forth. Since the center



of the two half-pulleys is always in line with the driven pulley, a standard V-belt and driven pulley can be used. Designed for operation at motor speeds. Winfield H. Smith, Inc., Springville, N. Y.

Reliance Single-Reduction Gearmotors

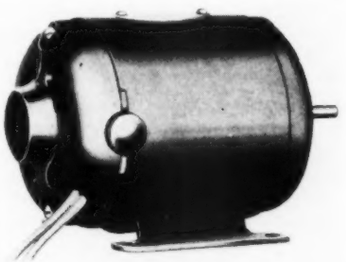
Designed with all units mounted on and removable from the gear-housing which supports the drive. Motor protected from oil by slingers, drains and multiple-groove seals. Gears are cut from alloy-steel forgings with helical teeth of full involute form. Pinions are case hardened, gears are oil hardened. Low-speed shaft carried on two ball bearings is made from chrome-nickel steel, heat-treated. Lubricant is supplied by the large gear dipping into the reservoir, oil passing through the bearings and carried back into the reservoir through drain passages. High-speed pinion is mounted on a



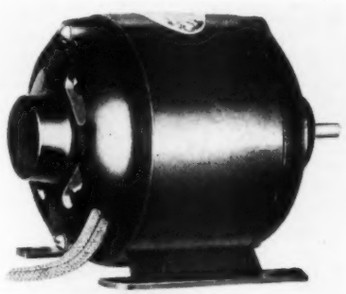
tapered extension of the motor shaft supported on a ball bearing. Designed so that stator can be removed leaving the rotor is place, or the rotor can be taken out without disturbing the connection between the gear motor and driven machine. Gears can also be taken out without disturbing the motor. Furnished with either a.c. or d.c. motors of various types in $\frac{3}{4}$-hp. sizes and larger. Reliance Electric & Engineering Co., 1092 Ivanhoe Road, Cleveland, Ohio.

G.E. Fractional Horsepower Motors

For office devices, portable tools and portable appliances, Type P universal motors have fabricated steel stator shells and die-cast end shields. Available in ratings from 1/100 to 1/3 hp. at speeds up to 10,000 r.p.m. Type KSP shaded-pole induction motors for small fans and blowers, advertising devices, timing devices, thermostats and valves, have spiralled rotor slots and a cast-aluminum squirrel-cage



Type KSP shaded-pole motor



Type P universal motor

winding to reduce noise. Available in ratings from 1/250 hp. to 1/60 hp. General Electric Co., Schenectady, N. Y.

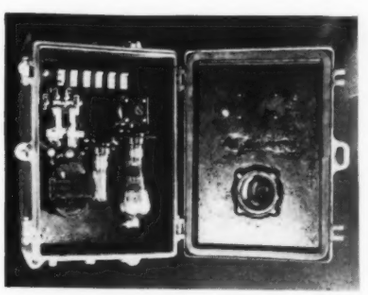
Lincoln Self-Protected Motor

Protector control mounted on the motor, is operated by a device built into the winding, shutting off the current when the temperature rises within the motor. Designed to protect the motor from overload, excess temperature caused by poor ventilation, or when a 3-phase motor runs on single

phase; is said to make possible the use of smaller motors in applications where large motors would otherwise be necessary to take care of only infrequent peak loads. Self-protected design available for a.c. induction motors from $\frac{1}{2}$ to 30 hp., 2 or 3 phase. The Lincoln Electric Co., Cleveland, Ohio.

Westinghouse Photo-Troller

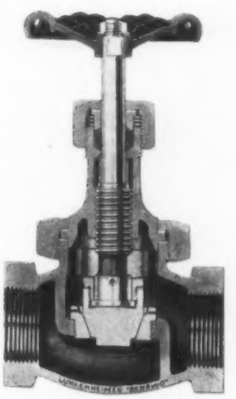
For photo-electric applications requiring operation at low light intensity, the indoor model operates on three footcandles, and with a suitable lens system will operate on as little as $\frac{1}{2}$ foot candle. With standard light sources



will cover up to a 50-ft. throw. Circuit incorporates a grid-glow tube operated by the photo-cell, both tubes of the industrial type designed for long operating life. Contactor operated by the grid-glow tube rated at 20 amp. at 115 volts or 15 amp. at 220 volts, a.c., with speeds of operation as high as 300 per min. Available for all commercial sources of power except d.c. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Lunkenheimer Plug-Type Valve

For severe service demanding maximum resistance to destructive action on valve seat bearings, these valves have alloy seats and disks made of a non-ferrous material said to be non-galling. Alloy has a hardness of 300 Brinell, is resistant to wear, abrasion, erosion and corrosion, and retains its hardness at high temperatures. Each



plug is ground into its own seat to a uniform bearing to insure a leakproof fit. Available in iron-body, bronze-mounted valves made for 150 lb., and in bronze valves for both 200 and 300 lb. service. Excepting bodies and bonnet rings, all parts are interchangeable. The Lunkenheimer Co., Cincinnati, Ohio.

Gall-Proof Thread Lubricant

Finely divided metallic lead in paste form recommended by the makers for use in initial assembly to assist in assembly and repair of machines subjected to heavy duty, high temperature and general abuse. Lubricant is said to form a film of lead in threads, taper fits, liners and studs, and prevents galling, corrosion or oxidation between the surfaces in contact. For exhaust manifolds and studs, lubricant is unaffected by a bright red heat. Armite Laboratories, 1900 E. 65th St., Los Angeles, Calif.

NEW BOOKS and PUBLICATIONS

America Self-Contained

Samuel Crowther. 340 pages, 5¼x8 in. Bound in cloth boards. Published by Doubleday, Doran & Co., Inc., Garden City, New York.

Here is the case for the establishment of a national economy free from reliance on any other country or region for raw materials or goods of any sort, and from financial entanglements with other nations, debtor or creditor. Mr. Crowther takes sharp issue with the Internationalists and those economists who adhere to the old British theory of the benefits of free trade. He does not insist on abolition of all trading with other countries but he does plead for the establishment of a set of national books of account that will enable us to decide whether any particular venture or transaction is economically justifiable.

Figure after figure is quoted to show that economic nationalism and our exports of production machinery have made any return to the old trading lines and volumes impossible. The author points out that scientific research has opened the door to freedom from the old dependence on foreign sources of certain basic materials, and begs us to enter into that freedom and work out our own destiny without the interference of lower-standard countries.

Principles of Metallurgy

Donald M. Liddell and Gilbert E. Doan. 626 pages, 6x9 in. Well illustrated. Dark red clothboard covers. Published by McGraw-Hill Book Co., Inc., 330 West 42d St., New York, N. Y. Price $5.50.

Half of the text, Part I and Part II, under headings "Materials Consumed in Metallurgy" and "Extractive Processes and Apparatus," covers subjects not of general interest to the designing engineer. However, in Part III, "Physical Metallurgy," Mr. Doan explains the basic nature of metallic materials and their properties from a practical engineering point of view. Such difficult subjects as atomic arrangement, solidification processes, crystal structure and X-ray analysis are given in an understandable style, with particular attention to the relationship between atomic and crystalline structure and the mechanical properties of engineering metals.

Constitutional diagrams and solubility effects are unmasked and explained in their relation to quenching and age hardening. A similar treatment is applied to the effect of internal structure on such properties as strength, formability, thermal expansion, melting point, magnetic condition and corrosion resistance. Metallurgical aspects of casting, hot and cold forming and welding are also given.

In the opinion of the reviewer, the designing engineer engaged in research or development work will find in this text an accurate and comprehensive, yet understandable treatment of crystalline structure and its effect upon the properties of metals.

Index to A.S.T.M. Standards

124 pages, 6x9 in. Paper covers. Published by the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. Available on request.

For assistance in locating the A.S.T.M. specifications and test methods, this 1933 edition is completely revised with the subject matter arranged in alphabetical order showing the publications in which the standards appear. A total of 689 standards and tentative standards are indexed, as well as methods of testing, recommended practices, definition of terms and charts and tables. Also included is a list of A.S.T.M. committees and publications of the society.

▼

Ball Bearings—The Fafnir Bearing Co., New Britain, Conn. Catalog 17, 8½x11 in., 24 pages, "Fafnir Ball Bearings and Power Transmission Units," includes uses, dimensions and prices for such types as single row radial, double row, radial-thrust, grease-seal, felt-seal, thrust and other types of ball bearings.

Ball Bearings — Norma-Hoffmann Bearings Corp., Stamford, Conn. Catalog 934-A, 8½x11 in., 12 pages, "Norma-Hoffmann Ball and Roller Bearing Pillow Blocks and Mountings," describes a line of pillow blocks and mountings using self-aligning bearings, for shafts from ⅛ to 8 in. in diameter. Load ratings, dimensions, mounting instructions and diagrams of typical applications are also included. Catalog F-936, 8½x11 in., 16 pages, "Norma-Hoffmann Precision Bearings for Aircraft Controls," describing bearings with and without metal or felt seals in straight and self-aligning types, with load data, dimensions and typical applications illustrated.

Belt Drives—Mechanical Power Engineering Associates, 684 St. Marks Ave., Brooklyn, N. Y. Booklet, 11x8½ in., 40 pages, "A Practical Analysis of Some Fundamentals of Industrial Power Transmission," includes a number of charts and diagrams illustrating the advantages of group drive over individual motor drive for certain applications.

Bimetal—W. M. Chace Valve Co., 1607 Beard Ave., Detroit, Mich. Booklet, 32 pages, 8½x11 in., "Thermostatic Bimetal," illustrates the differential-expansion principle, applications, forms and available types. Design information, charts and tables cover characteristics, working temperature, deflections, torque, heat-treatment, electrical resistance and shape of bimetal elements.

Dowmetal—Dow Chemical Co., Midland, Mich. Booklet, 8½x11 in., 68 pages, "Dowmetal," contains complete engineering data on light-weight alloys composed of 85 to 99 per cent magnesium. Uses are described and illustrated, available forms listed. Design factors and complete tables of physical properties are included as well as information on shop practice and available standard shapes. An appendix gives protective and decorative finishes.

Gears—Poole Foundry & Machine Co., Baltimore, Md. Catalog 34, 5½x8½ in., 302 pages, "Poole Machine Molded Gears." Following a foreword of ten pages which covers a description of the molding process and data on horsepower ratings, the remainder of the book lists approximately 10,000 sizes of machines, molded gears arranged in order of pitch number for each type. Complete tabulated data are given on each type of gear, including spur, bevel, mitre, herringbone, internal, mortise and worm gears.

Magnetic Testing—The A. V. de Forest Associates, 25 West 43d St., New York, N. Y. Folder, 4 pages, "Magnaflux," describing a rapid nondestructive method of locating defects in steel and magnetic alloys.

Machine Gas Cutting—Air Reduction Sales Co., 60 East 42d St., New York, N. Y. Booklet, 8½x11 in., 92 pages, "Machine Gas Cutting," is attractively illustrated, gives in detail the design advantages and shop procedure in the use of machine-driven oxyacetylene cutting torches. Included are illustrations of many unusual designs made possible by this equipment.

Roller Bearings — Roller Bearing Company of America, Trenton, N. J. Leaflet, 4 pages, giving capacities and dimensions for a line of solid roller, self-contained bearings.

V-Belt Pulleys—Allis-Chalmers Mfg. Co., Milwaukee, Wis. Leaflet, 4 pages, giving engineering data on Texsteel Sheaves for Texrope Drives.

Total Efficiency for Drive Trains

Efficiency = $0.98^a \times 0.95^b \times 0.90^c$

A. C. RASMUSSEN
Insley Manufacturing Company

For drive trains involving various gear combinations such as well-lubricated steel gears, open machined gears, cast-iron gears and chain drives, one of three values for efficiency—0.98, 0.95 or 0.90—will apply for each step in most designs. The total efficiency, which is the product of the efficiencies at each step, is found by the above formula where exponents *a*, *b* and *c* represent the number of times in the step drive that the corresponding efficiency value appears. Solutions for the formula can be read directly from this table.

As an example, a drive has a reduction through inclosed machined gears running in oil with an efficiency of 0.98, a second reduction by chain with an efficiency of 0.90, third and fourth reductions by open machined gears with 0.95 efficiency at each contact, and a fifth reduction through well-lubricated machine gears with an efficiency of 0.98. For this drive $a = 2$, $b = 2$, and $c = 1$. The total efficiency formula is:

$$\text{Efficiency} = 0.98^2 \times 0.95^2 \times 0.90$$

In the section of the table headed $c = 1$, in column headed $a = 2$, in line $b = 2$, the figure 0.7801 is given as the total efficiency of the drive.

Exponent $c = 0$

Exponent a =		0	1	2	3	4	5	6
Exponent b =	0	1.000	0.9800	0.9604	0.9412	0.9224	0.9039	0.8858
	1	0.9500	0.9310	0.9124	0.8941	0.8762	0.8587	0.8416
	2	0.9025	0.8845	0.8668	0.8494	0.8324	0.8158	0.7995
	3	0.8574	0.8402	0.8234	0.8070	0.7908	0.7750	0.7595
	4	0.8145	0.7982	0.7823	0.7666	0.7513	0.7362	0.7215
	5	0.7738	0.7583	0.7431	0.7283	0.7137	0.6994	0.6854
	6	0.7351	0.7204	0.7060	0.6919	0.6780	0.6645	0.6512

Exponent $c = 1$

Exponent a =		0	1	2	3	4	5	6
Exponent b =	0	0.9000	0.8820	0.8644	0.8471	0.8301	0.8135	0.7973
	1	0.8550	0.8379	0.8211	0.8047	0.7886	0.7729	0.7574
	2	0.8123	0.7960	0.7801	0.7645	0.7492	0.7342	0.7195
	3	0.7716	0.7562	0.7411	0.7263	0.7117	0.6975	0.6835
	4	0.7331	0.7184	0.7040	0.6899	0.6761	0.6626	0.6494
	5	0.6964	0.6825	0.6688	0.6554	0.6423	0.6295	0.6169
	6	0.6616	0.6484	0.6354	0.6227	0.6102	0.5980	0.5861

Exponent $c = 2$

Exponent a =		0	1	2	3	4	5	6
Exponent b =	0	0.8100	0.7938	0.7779	0.7624	0.7471	0.7322	0.7175
	1	0.7695	0.7541	0.7390	0.7242	0.7098	0.6956	0.6817
	2	0.7310	0.7164	0.7021	0.6880	0.6743	0.6608	0.6476
	3	0.6945	0.6806	0.6670	0.6536	0.6406	0.6277	0.6152
	4	0.6598	0.6466	0.6336	0.6210	0.6085	0.5964	0.5844
	5	0.6268	0.6142	0.6019	0.5899	0.5781	0.5665	0.5552
	6	0.5954	0.5835	0.5718	0.5604	0.5492	0.5382	0.5275

Exponent $c = 3$

Exponent a =		0	1	2	3	4	5	6
Exponent b =	0	0.7290	0.7144	0.7001	0.6861	0.6724	0.6590	0.6458
	1	0.6926	0.6787	0.6651	0.6518	0.6388	0.6260	0.6135
	2	0.6579	0.6448	0.6319	0.6192	0.6068	0.5947	0.5828
	3	0.6250	0.6125	0.6003	0.5883	0.5765	0.5650	0.5537
	4	0.5938	0.5819	0.5703	0.5589	0.5477	0.5367	0.5260
	5	0.5641	0.5528	0.5417	0.5309	0.5203	0.5099	0.4997
	6	0.5359	0.5252	0.5147	0.5044	0.4943	0.4844	0.4747

PRODUCT ENGINEERING © REFERENCE BOOK SHEET

Barth Gear Factors

A. C. RASMUSSEN
Insley Manufacturing Company

In gear teeth greater stresses result from impact, the stresses increasing with the pitch line velocity. The magnitude of these stresses depends on a number of factors, such as tooth shape, accuracy of tooth profile, stiffness of shaft, bearing play and the elastic modulus of the material. The most important factor is the accuracy of profile since accurately machined and ground gears may reduce the impact as much as 50 per cent. The use of ball or roller bearings also reduces impact stresses by eliminating bearing play, particularly when preloaded bearings are used. While other conditions also influence the impact stresses, they are not as important as the profile accuracy and bearing play.

To allow for these greater stresses the static stress is multiplied by a factor which is commonly determined by the empirical formula developed by Barth. The Barth factor A is calculated in terms of pitch line velocity V in ft. per min., and constant a, as given by the following equation:

$$A = \frac{a}{a - V}$$

Factors in the following table are given for two values of a: 600 for ordinary machined gears, and 1,200 for accurately machined gears mounted on ball or roller bearings. For pitch line velocities intermediate between those given in the table, the factor corresponding to the next higher pitch line velocity should be used.

Factor A	Pitch Line Velocity ft. per min.		Factor A	Pitch Line Velocity ft. per min.		Factor A	Pitch Line Velocity ft. per min.	
	a = 600	a = 1200		a = 600	a = 1200		a = 600	a = 1200
1.00	3	6	0.73	228	455	0.46	719	1437
0.99	9	18	0.72	239	478	0.45	748	1497
0.98	15	31	0.71	251	502	0.44	779	1559
0.97	22	43	0.70	263	527	0.43	812	1623
0.96	28	57	0.69	276	552	0.42	846	1692
0.95	35	70	0.68	289	578	0.41	881	1763
0.94	42	83	0.67	302	605	0.40	919	1838
0.93	48	97	0.66	316	632	0.39	958	1917
0.92	56	111	0.65	330	660	0.38	1000	2000
0.91	63	126	0.64	345	690	0.37	1044	2088
0.90	70	141	0.63	360	720	0.36	1090	2180
0.89	78	156	0.62	376	751	0.35	1139	2278
0.88	86	171	0.61	392	783	0.34	1191	2382
0.87	94	187	0.60	408	817	0.33	1246	2492
0.86	102	203	0.59	426	851	0.32	1305	2610
0.85	110	220	0.58	443	887	0.31	1367	2734
0.84	119	237	0.57	462	924	0.30	1434	2868
0.83	127	255	0.56	481	962	0.29	1505	3011
0.82	136	272	0.55	501	1002	0.28	1582	3164
0.81	145	291	0.54	522	1043	0.27	1664	3328
0.80	155	309	0.53	543	1086	0.26	1753	3506
0.79	164	329	0.52	565	1130	0.25	1849	3698
0.78	174	348	0.51	588	1176	0.24	1953	3906
0.77	184	369	0.50	612	1224	0.23	2067	4133
0.76	195	389	0.49	637	1274	0.22	2191	4381
0.75	205	411	0.48	663	1326	0.21	2327	4653
0.74	216	432	0.47	690	1381			

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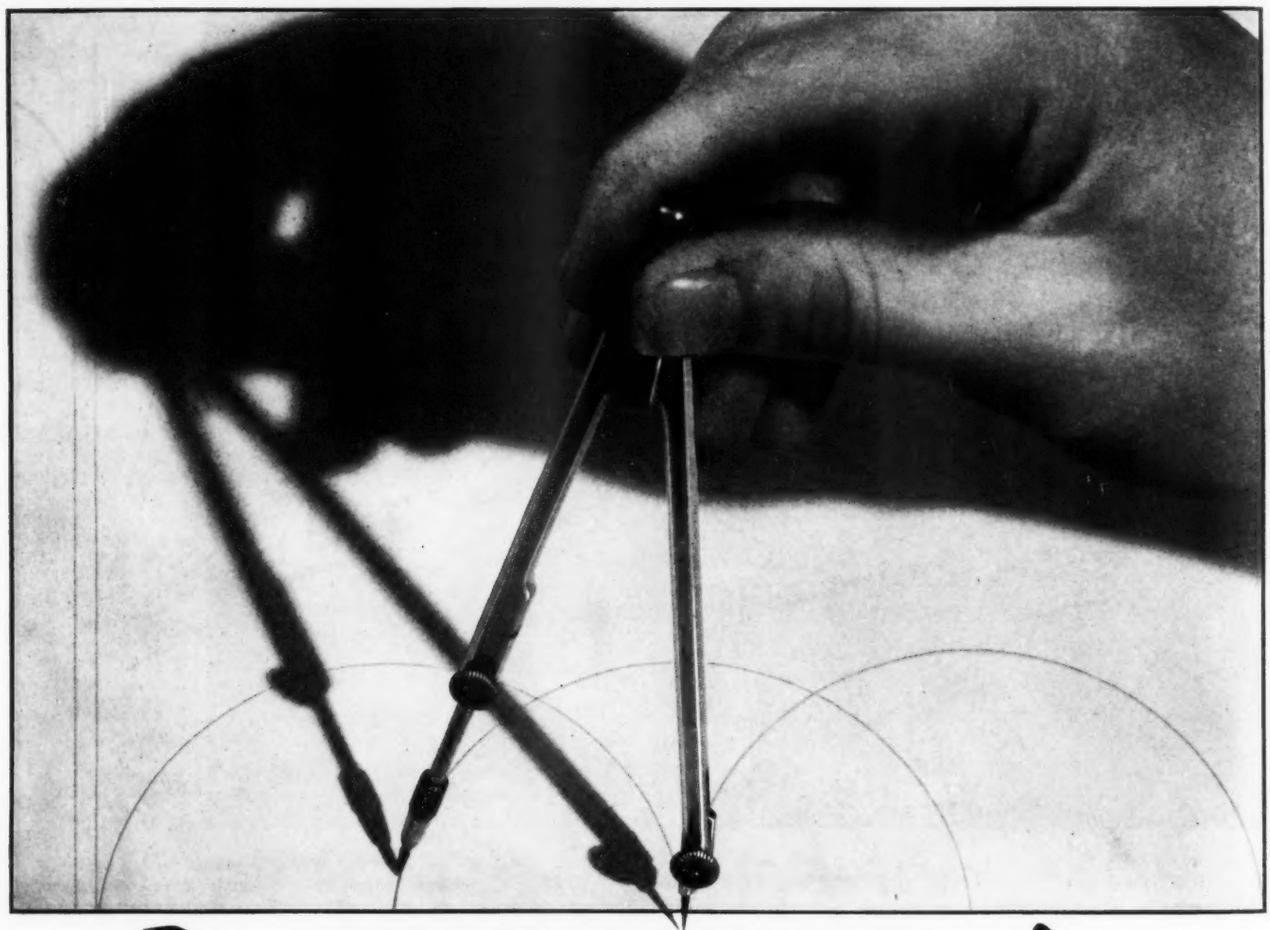

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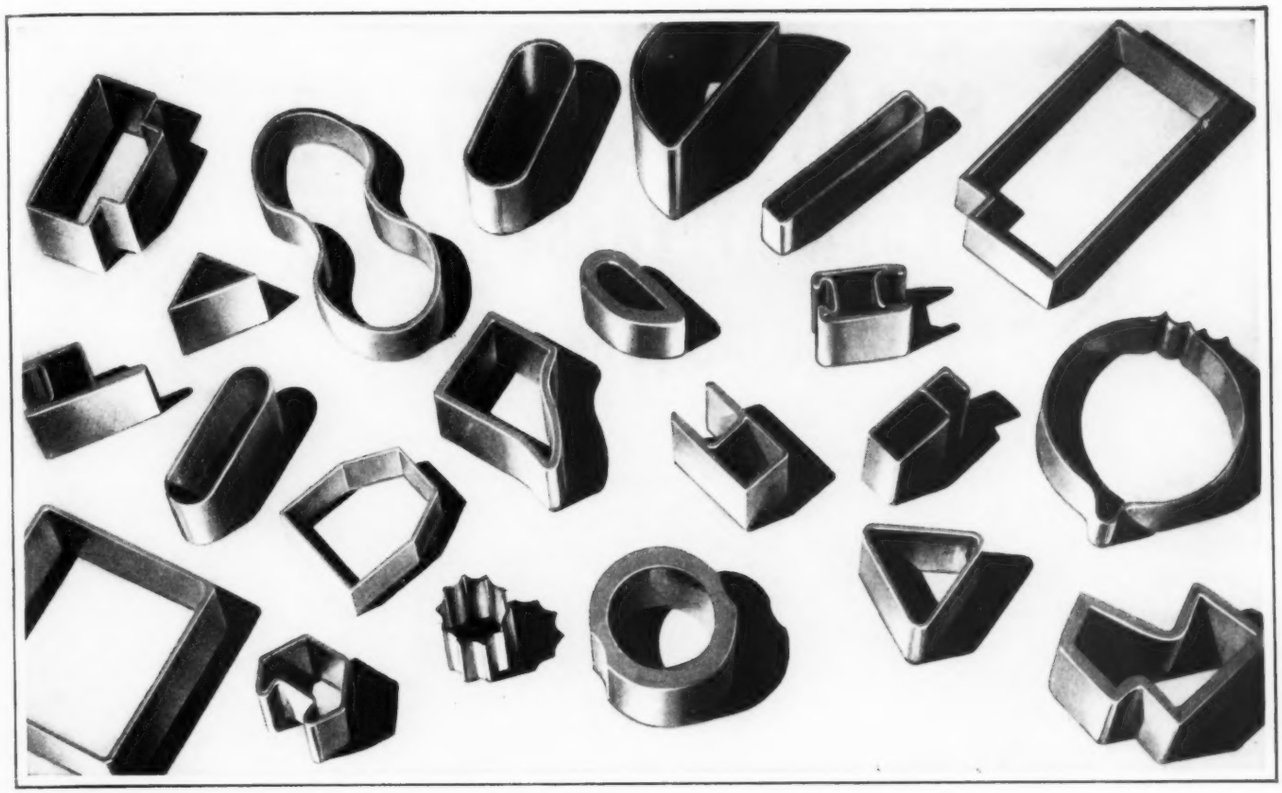

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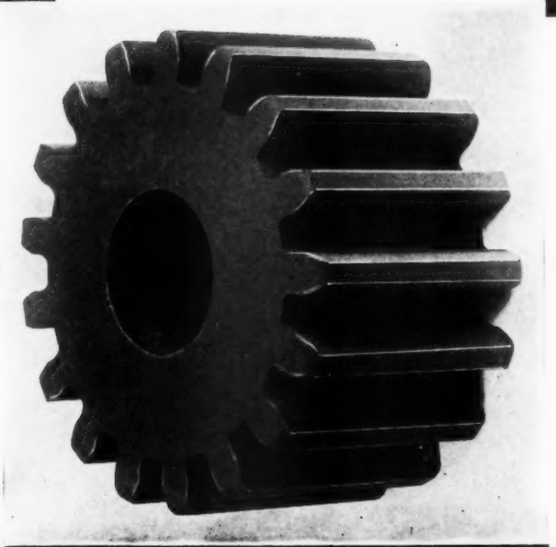

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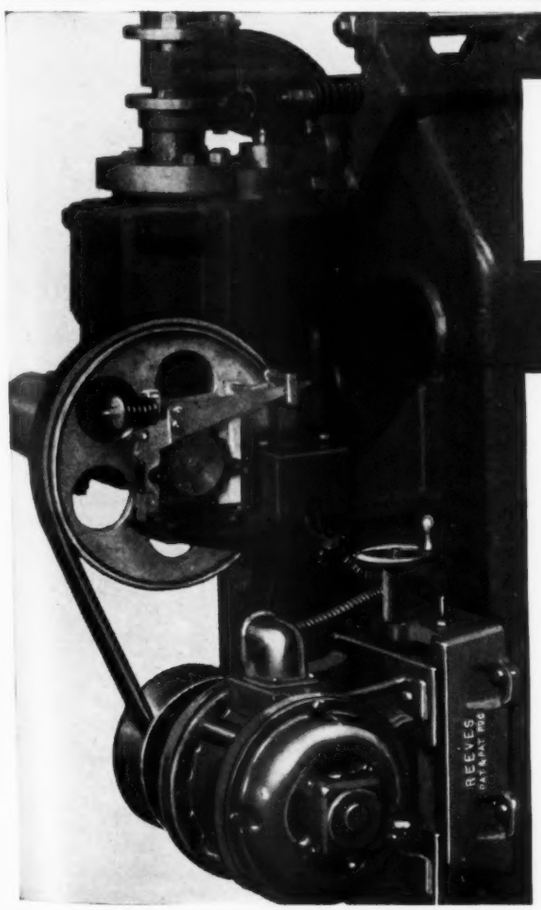

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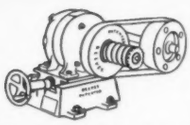

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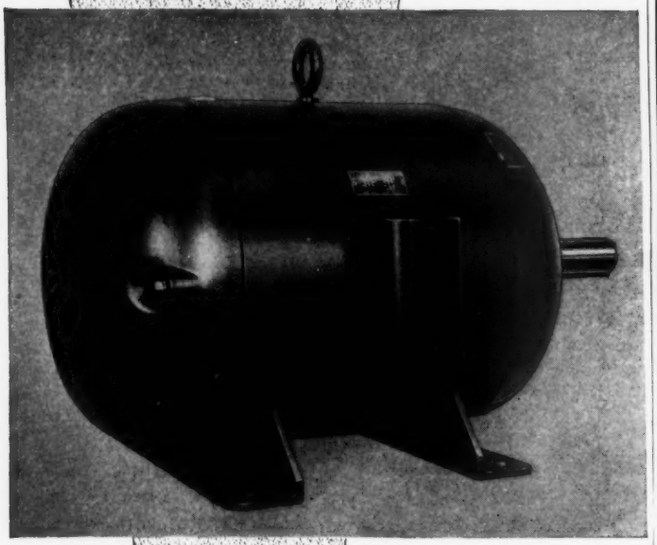

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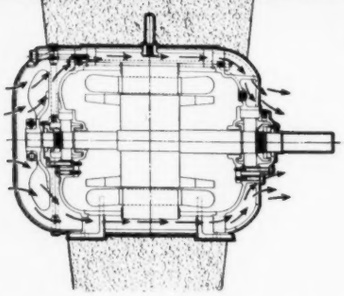

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